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Parametric Evaluation of VOC/HAP (Volatile Organic Compounds-Hazardous/Toxic Air Pollutants) Destruction via Catalytic Incinerations

Radian Corp., Research Triangle Park, NC

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PARAMETRIC EVALUATION OF VOC/HAP DESTRUCTION VIA CATALYTIC INCINERATION

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16. ABSTRACT

The report describes the use of a pilot-scale catalytic incineration unit/solvent generation system to investigate the effectiveness of catalytic incineration as a way to destroy volatile organic compounds (VOCs) and hazardous/toxic air pollutants (HAPs). Objectives of the study were to: (1) investigate the effects of operating and design variables on the destruction efficiency of VOC/HAP mixtures, and (2) evaluate destruction efficiencies for specific compounds in different chemical classes. Study results verified that the following factors affect catalyst performance: inlet temperature, space velocity, catalyst geometry, compound type, compound inlet concentration, and mixture composition. Tests showed that destruction efficiencies exceeding 98 percent were possible (given sufficiently high inlet temperatures/low space velocities) for the following compounds/compound classes: alcohols, acetates, ketones, cellosolves/dioxane, aldehydes, aromatics, and ethylene/ethylene oxide. Destruction efficiencies of at least 97 percent were achieved for acrylonitrile and cresol. Chlorinated hydrocarbons were not effectively destroyed with the type of catalyst used in this study.

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Incinerators	Stationary Sources	
Catalysis	Volatile Organic Compounds	07D
Toxicity		06T
Organic Compounds	Hazardous/Toxic Air Pollutants	07C
Volatility		

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ABSTRACT

A pilot-scale catalytic incineration unit/solvent generation system was used to investigate the effectiveness of catalytic incineration as a means of destroying volatile organic compounds (VOC) and hazardous/toxic air pollutants (HAP). The objectives of the study were to: (1) investigate the effects of operating and design variables on the destruction efficiency of VOC/HAP mixtures, and (2) evaluate destruction efficiencies for specific compounds in different chemical classes. The study results verified that the following factors affect catalyst performance: inlet temperature; space velocity; superficial gas velocity; catalyst geometry; compound type; compound inlet concentration; and mixture composition. Test showed that destruction efficiencies exceeding 98 percent were possible (given sufficiently high inlet temperatures/low space velocities) for the following compounds/compound classes: alcohols, acetates, ketones, cellosolves/dioxane, aldehydes, aromatics and ethylene/ethylene oxide. Destruction efficiences of at least 97 percent were achieved for acrylonitrile and cresol. Chlorinated hydrocarbons were not effectively destroyed with the type of catalyst used in this study.

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1.0 INTRODUCTION

Radian Corporation has completed a test program for the EPA (Contract Nos. 68-02-3171 and 68-02-3515) to investigate on an experimental scale the effectiveness of catalytic incineration as a means of destroying volatile organic compounds (VOC) and hazardous/toxic air pollutants (HAP). A pilot-scale catalytic incineration unit and a solvent vapor generation system were used to conduct this testing. Prior to the completion of this study, limited data were publicly available on the performance of catalytic incinerators for a large number of compounds over a wide range of operating conditions. Thus, objectives of this study were to (1) investigate the effects of key incinerator operating and design parameters on mixture destruction efficiency and (2) measure component specific destruction efficiencies for compounds in different chemical classes. All measurements were conducted in accordance with a Quality Assurance Project Plan approved by EPA.

This report is divided into eight sections. A summary of the experimental approach and the test results is presented in Section 2. The incineration unit and the solvent vapor generation system are described in Section 3 and details of the experimental design are discussed in Section 4. Sampling and analytical methods are discussed in Section 5. Statistical techniques used in the data analysis are presented in Section 6 and results of testing and analysis are discussed in Section 7. The final section lists conclusions and recommendations based on the study. Quality Assurance and Quality Control Results are presented in Appendix C.

2.0 SUMMARY

The effects of key operating and design parameters on the destruction efficiency of a skid-mounted catalytic incineration unit were investigated using a solvent vapor generation system. The vapor generation system, which consisted of a pump, dry gas meter, tube furnace, glass mixing chamber and motor-driven syringes, was used to produce a spiked air stream with the desired concentrations of organic vapors. The skid-mounted unit, which was leased from Engelhard Industries, was equipped with a blower, preheater, mass flowmeter, catalytic reactor and temperature controls. The design gas flowrate for the catalytic test unit was 275 cfh (4.6 scfm).*

In designing the experimental program, conditions were selected to (1) provide data on a large number of compound types, (2) give an indication of the operating conditions required for destruction efficiencies near 98 or 99 percent, and (3) represent operating conditions typically used in industrial applications. The major operating parameters that were varied during the testing included: catalyst inlet temperature, compound concentration, space velocity, compound type, catalyst geometry, and catalyst volume. Much of the testing was conducted to characterize compound destruction across the preheater and catalyst bed as a "system." However, heater and catalyst destruction efficiencies were also measured separately at a number of conditions.

The majority of the test work involved the measurement of destruction efficiencies for low concentrations of VOC/HAP mixtures in air. A short series of tests were also conducted with a low oxygen gas stream, intended to simulate the off-gas from an ethylene oxide production process. Components of the VOC/HAP mixtures and compositions of the simulated ethylene oxide off-gases are shown in Tables 2-1 and 2-2 respectively. For the VOC/HAP mixtures, total system inlet concentrations were typically maintained near 1200 ppmC (parts per million by volume as carbon). Mixtures were generally prepared to provide equal amounts of each component on a per carbon or ppmC basis. At all test conditions, total mixture destruction efficiencies were measured with EPA Method 25A and component specific efficiencies were determined by EPA Method 18.

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*To conform with general engineering practice, English Engineering units rather than metric units are normally used in this report. Appendix B provides conversion factors from English Engineering to International System (SI) units.

The ranges of incinerator operating conditions tested during this study are summarized in Table 2-3. As shown in Table 2-3, space velocities, based on total catalyst volume and standard gas flow rates, were varied from 15,000 to 80,000 hr^{-1} with catalyst inlet temperatures ranging from 500 to 800°F. Two volumes of two different catalyst geometries were tested. The larger catalyst volume was obtained by lengthening the catalyst bed while maintaining the same cross-sectional area. Both catalyst geometries had the same precious metals formulation. However, the ceramic honeycomb substrates had different cell sizes, and hence, different catalyst surface areas.

Results from the pilot-scale catalytic incineration testing identified and/or verified the effects of a number of operating and design parameters on catalytic incineator performance. Parameters found to have the greatest effect on destruction included catalyst inlet temperature, space velocity, compound type, catalyst geometry and catalyst volume. Other parameters generally showing a lesser effect included inlet concentration and mixture composition. The test results provided data on (1) potential partial oxidation products, (2) carbon monoxide emissions, and (3) catalyst temperature rise relationships. The capability of catalytic incineration to achieve destruction efficiencies in the 98 to 99 percent range was also verified for compounds in seven different chemical classes.

TABLE 2-1. LISTS OF COMPONENTS IN MULTICOMPONENT VOC/HAP MIXTURES

Mixture 1 - Control Mixture

- Isopropanol
- Methyl ethyl ketone
- Ethyl acetate
- Benzene
- n-Hexane

Mixture 1A - Hexane Substitution

- Isopropanol
- Methyl ethyl ketone
- Ethyl acetate
- Benzene
- Cyclohexane

Mixture 1B - Hexane Substitution

- Isopropanol
- Methyl ethyl ketone
- Ethyl acetate
- Benzene
- Iso-octane

Mixture 1C - Hexane Substitution

- Isopropanol
- Methyl ethyl ketone
- Ethyl acetate
- Benzene
- n-Octane

Mixture 2 - Industrial Mixture

- Methyl ethyl ketone
- Toluene

Mixture 3 - Alcohols/Acetates

- Methanol
- Ethanol
- Isopropanol
- n-Butanol
- Ethyl acetate
- n-Propyl acetate
- Isobutyl acetate

Mixture 4 - Ketones/Miscellaneous Oxygenated Compounds

- Acetone
- Methyl ethyl ketone
- Methyl isobutyl ketone
- Cyclohexanne
- Ethyl cellosolve
- Butyl cellosolve
- Dioxane

Mixture 5 - Aldehydes

- Propionaldehyde
- Isobutyl aldehyde
- Isovaleraldehyde
- n-butyl aldehyde
- n-Valeraldehyde

Mixture 6 - Alkanes/Aromatics

- n-Hexane
- n-Octane
- n-Decane
- Benzene
- Toluene
- m-Xylene
- Isopropyl benzene

Mixture 7 - Non-Chlorinated HAP's

- m-Cresol
- Acrylonitrile

Mixture 8 - Chlorinated HAP's

- Methylene chloride
- Carbon tetrachloride
- Ethylene dichloride
- Trichloroethylene
- Tetrachloroethylene
- 1,1-Dichloroethane
- 1,1,2-Trichloroethane

TABLE 2-2. COMPONENTS AND CONCENTRATIONS IN THE ETHYLENE OXIDE OFF-GAS

Test Parameter	Conditions or Values Tested	
Stream Composition I (percent by volume)	Ethylene	0.43%
	Ethane	0.09%
	Ethylene oxide	0.01%
	Nitrogen	86.0%
	Carbon dioxide	12.0%
	Oxygen	1.5%
Stream Composition II (percent by volume)	Ethylene	0.64%
	Ethane	0.09%
	Ethylene oxide	0.01%
	Nitrogen	85.3%
	Carbon dioxide	11.5%
	Oxygen	2.5%

TABLE 2-3. RANGES OF OPERATING CONDITIONS TESTED

Catalyst Geometry Volume[a]	Mixture(s) Tested	Range Of Space Velocity (hr^{-1})	Inlet Concentrations (ppmC)[b]	Catalyst Inlet Temperatures (°F)
A/0.006 ft^3	1 through 8 plus pure compounds[c]	20,000 to 80,000	1,200/6,000 10,000	500 to 800
B/0.006 ft^3	1,6	30,000 and 50,000	1,200	600 to 800
A/0.012 ft^3	1,2,4,6	15,000 to 50,000	1,200	600 to 800
A/0.012 ft^3	Ethylene Oxide	30,000 and 50,000	I, II[d]	500 and 600
B/0.012 ft^3	Ethylene Oxide	30,000 and 50,000	I[d]	500 and 600

[a] Catalyst A had a catalyst surface area of 270 ft^2/ft^3 and Catalyst B had an area of 660 ft^2/ft^3.

[b] ppmC = parts per million by volume as carbon.

[c] Sixteen single components tested with this catalyst.

[d] Compositions shown in Table 2-2.

Multi-component mixture effects on compound specific destruction efficiencies were evaluated by comparing pure compound destruction efficiencies with efficiencies of these compounds as components of the VOC test mixtures. In addition, destruction efficiencies for compounds tested in more than one mixture were compared. A mixture effect was found on pure compound destruction efficiencies for six of thirteen compounds. In most cases, these compounds showed higher destruction efficiencies as mixture components than as pure compounds. However, two linear alkanes, n-hexane and n-octane, showed decreased destruction as components of one mixture.

An effect of mixture composition was also found for two of five compounds tested in more than one mixture. This effect appeared to be greatest at lower catalyst inlet temperatures.

The effects of catalyst inlet temperature and space velocity on system destruction efficiency are shown for Mixture 1 in Figure 2-1. The trends shown in Figure 2-1 of increasing destruction with increasing inlet temperature and decreasing space velocity are typical of those observed for the other mixtures. System destruction efficiencies for Mixture 3 (alcohols and acetates) showed a particularly strong dependence on catalyst inlet temperature at a space velocity of 50,000 hr^{-1}. In addition, system destruction efficiencies for Mixtures 3 and 6 (alkanes and aromatics) showed a strong dependence on space velocity.

Test Mixture 5, which consisted of different aldehyde compounds, generally showed the highest system destruction efficiencies of the mixtures tested. Mixture 8, which contained seven chlorinated hydrocarbons, showed by far the lowest destruction. With the exception of Mixture 8, all mixtures showed system destruction efficiencies ranging from 85 to 98 percent for the conditions tested in this study. Mixture 8 destruction efficiencies ranged from 0.0 to 80 percent.

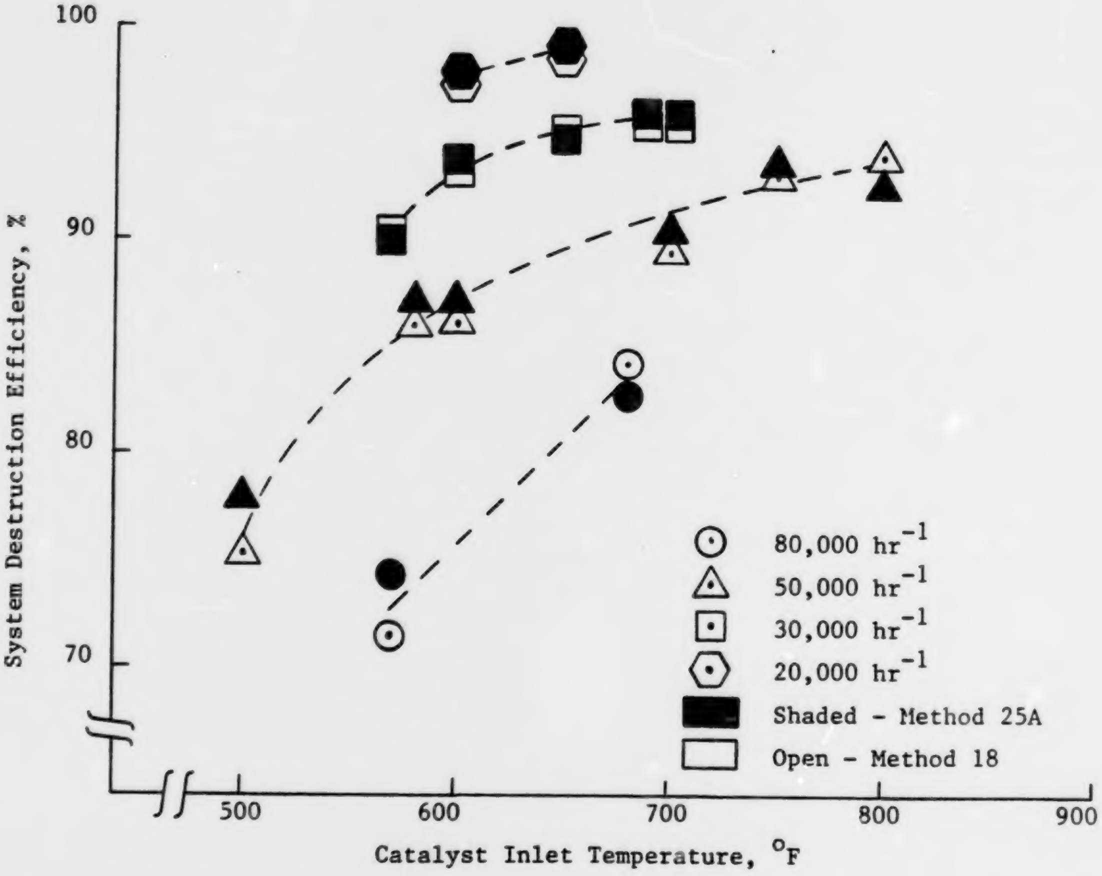

Figure 2-1. Mixture 1 system destruction efficiency vs. inlet temperature for small volume catalyst A.

The preheater on the test unit consisted of a pipe or tube wrapped with a high temperature electrical resistance heater element. At low space velocities and/or high inlet temperatures with the small catalyst volumes, heater (thermal) destruction efficiencies were as high as 80 to 90 percent for some mixtures. With the larger volume, gas flow rates through the system were doubled at a given space velocity and heater destruction decreased to between 10 and 76 percent. The degree to which the heater destruction efficiencies observed on the test unit may represent destruction in the natural gas burner zones of full-scale incinerators is not known. However, burner designs that provide direct contact of the waste gas with the flame are expected to provide an opportunity for a significant amount of solvent destruction.

At a given space velocity, catalyst destruction efficiencies for the mixtures were found to be higher for the larger catalyst volume. The higher destruction for the large volume results from a higher gas velocity through the catalyst cells, which apparently improved mass transfer and increased the overall reaction rate. With the larger catalyst volume, catalyst destruction efficiencies of 98 percent or higher were obtained for Mixtures 1, 3, 4, and 6.

The effect of catalyst inlet temperature and space velocity on component destruction efficiencies varied considerably for the different compounds. Compounds of the same chemical class often showed similar destruction efficiencies and trends with inlet temperature.

Other results from the catalytic incineration testing included the following:

- Tests with the chlorinated hydrocarbon mixture were found to have partially deactivated the catalyst.

- Higher destruction efficiencies were observed for the catalyst geometry with the higher surface area (catalyst B), as expected.
- Inlet concentration was found to slightly affect destruction, with higher efficiencies at higher concentrations.
- Tests with the simulated ethylene oxide off-gas showed VOC destruction efficiencies in excess of 99 percent at all conditions tested.
- The pilot-scale efficiencies for Mixture 2 agreed well with those for a full-scale unit treating this same mixture in exhaust gas from a foil coil coating line.
- Mass spectroscopy analysis identified partial oxidation products from the catalytic combustion test unit.
- Carbon monoxide emissions from catalytic combustion were found to be less than 5 ppmv for most test conditions.
- Catalyst bed temperature rise was found to be directly related to the mass of solvent destroyed in the catalyst bed.
- Method 25A and Method 18 mixture destruction efficiencies were in very good agreement, with Method 25A efficiencies being 2.4 percent lower on average for the entire test effort.

3.0 TEST SYSTEM DESCRIPTION

The test system for this study consisted of a skid-mounted catalytic incineration unit and a solvent vapor generation system. The skid-mounted unit, which was leased from Engelhard Industries, was equipped with a blower, preheater, mass flowmeter, catalytic reactor and temperature controls. This unit is described in Section 3.1.

For most of the incineration testing, solvent vapor was generated by evaporating liquid solvent mixtures into a clean air stream at a controlled rate. However, a limited amount of tests were also conducted feeding test compounds vapor directly from gas cylinders into a nitrogen rich (85 percent) gas stream. These systems are described in Section 3.2.

3.1 INCINERATION UNIT DESCRIPTION

A schematic diagram of the pilot-scale catalytic incineration unit is shown in Figure 3-1. Gases, drawn from the solvent generation system with a small blower, were metered into the unit with a manual valve and a Teledyne Hastings^{R} mass flowmeter. Metered flowrates ranged from 2.0 to 10 scfm. Prior to entering the catalyst bed, the gases were heated to the desired temperature with a controlled electric preheater. The test compounds were oxidized on the catalyst bed and the exhaust was vented to the atmosphere. Heat loss from the catalyst bed was minimized by a second electric heater controlling the temperature of the catalyst shell. A damper on the system exhaust maintained a slight positive pressure throughout the system to prevent air inleakage at the sample locations.

Two volumes of two different catalyst geometries were tested during this program. The characteristics of each catalyst are summarized in Table 3-1. The catalyst beds consisted of catalyst coated ceramic honeycombs

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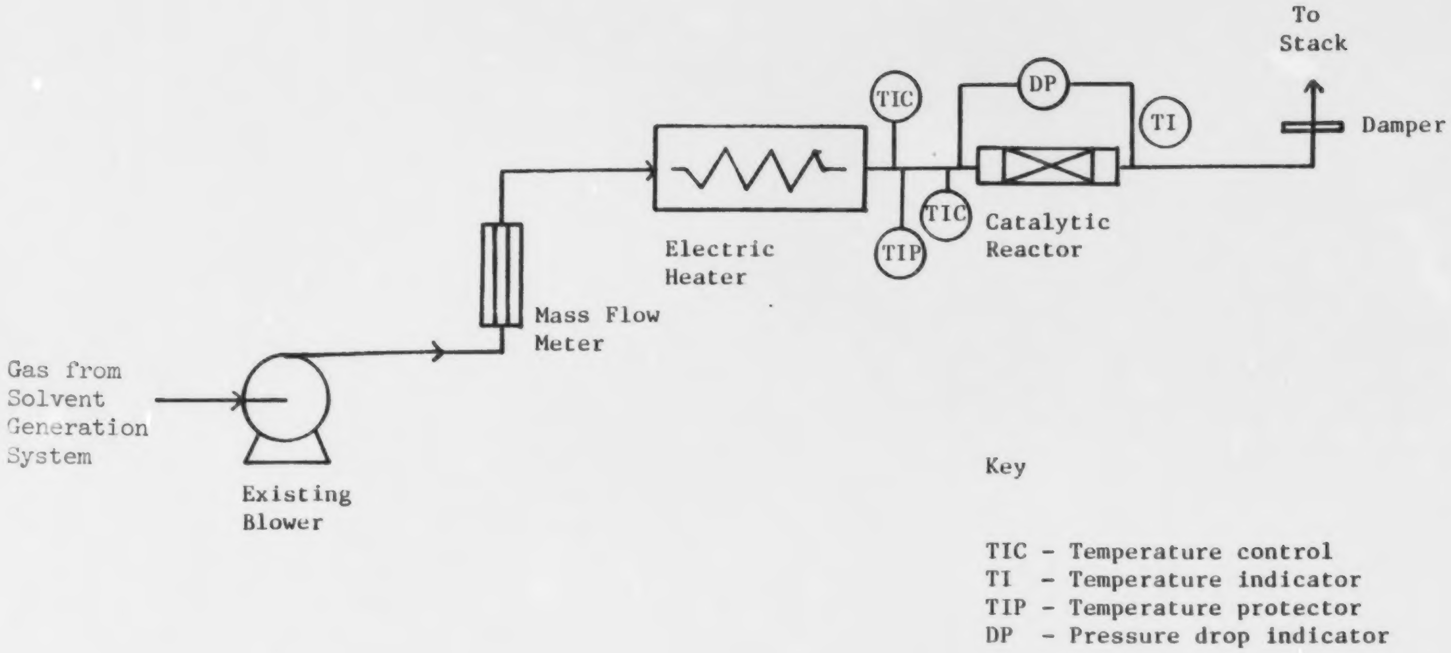
Gas from
Solvent
Generation
System
Existing
Blower
Mass Flow
Meter
Electric
Heater
TIC
TIP
TIC
DP
TI
Catalytic
Reactor
To
Stack
Damper
Key
TIC - Temperature control
TI - Temperature indicator
TIP - Temperature protector
DP - Pressure drop indicator

Figure 3-1. Pilot Incineration Unit Flow Diagram.

TABLE 3-1. CHARACTERISTICS OF CATALYSTS[a]

Catalyst Type[a]	Catalyst Volume (ft^3)	Bed Dimensions Diameter (in.)	Bed Dimensions Length (in.)	Cell Diameter (in.)	Cell Density (Cells/in.^{2})	Void Fraction (%)	Approximate Surface Area (ft^2/ft^3)
A	0.006	1.5	6	0.109	65	61	270
A	0.012	1.5	12	0.109	65	61	270
B	0.006	1.5	6	0.046	300	63	660
B	0.012	1.5	12	0.046	300	63	660

[a] Note: All catalysts had same precions metals formulation on (platinum/paladium) ceramic honeycomb substrate.

with either 0.109 or 0.046 diameter inch cells. Catalyst A, which had the larger cell size, is the standard Torvex^R hydrocarbon abatement catalyst currently applied in such industries as can, coil and auto body coating. Catalyst B had the same precious metals (platinum/paladium) formulation, with a smaller cell size and a correspondingly larger surface area. Catalyst B is more suited for applications requiring high destruction efficiencies. The beds were cylindrical in shape with a 1.5 inch diameter and either a 6 or 12 inch length, giving total catalyst volumes of 0.006 or 0.012 ft^3 respectively. Space velocities tested with the catalysts ranged from 20,000 to 80,000 hr^{-1} for the smaller volume and 15,000 to 50,000 hr^{-1} for the larger volume.

The electric preheater on the incineration unit consisted simply of a pipe or tube wrapped with an electrical resistance heater element. The heater element had a maximum operating temperature of approximately 1200°F. This maximum heater element operating temperature limited the catalyst inlet temperature that could be achieved at low system flowrates (at or below 5 scfm). The maximum obtainable catalyst inlet temperature ranged from 600°F at 2.0 scfm to 850°F at 5 scfm. Higher catalyst temperatures were achievable at higher gas flow rates because increased turbulence in the heater tube improved heat transfer from the tube walls to the bulk gas. At the lower flow rates (near 2 scfm), gas flow through the tube was laminar and at the higher flow rates (above 5 scfm) the gas flow became turbulent. Maximum inlet temperatures for flows above 5 scfm were not determined during this program.

Instrumentation on the pilot unit included controllers for the catalyst inlet and outlet temperatures and the catalyst bed shell temperature. Other indicators provided measurements of main preheater and shell heater element temperatures and catalyst bed pressure drop.

3.2 SOLVENT VAPOR GENERATION SYSTEM

The solvent vapor generation system provided spiked air streams with various concentrations of organic vapors for incineration. This system, as shown in Figure 3-2, begins with a Dayton Model 4Z469 rotary vane pump which provided the gas for vaporizing and carrying the solvents into the incinerator. This pump was capable of pumping room air into the system at a free flow rate of 17 acfm. The air was then scrubbed with activated charcoal to remove ambient organic vapors present in room air. This was accomplished with a Tigg Corporation Nitox N100 containing 150 pounds of activated charcoal in a 55 gallon drum.

Gas flowrate was measured with a Sprague Meter Company dry gas meter, which has the capacity to measure up to 17 acfm. Temperature and pressure of the gas stream at the meter were measured with a thermocouple/digital readout and a Magnehelic pressure measurement gauge respectively. Shortly after the gas passed through the meter, it was heated by two methods. Heating tapes powered by variable transformers heated all exposed tubing and parts from the meter to the exit of the mixing chamber. In addition, a resistance type tube furnace was used to provide additional heat to a section of the tubing prior to the points of solvent injection.

The solvent injection, vaporization, and mixing all occurred in a custom-made glass unit. The unit contained four 1/4" o.d. solvent injection parts set into a ½" o.d. inlet at a 45° angle. This injection design was believed to prevent blowback of solvent into the injection ports. The injection ports were sealed with Swagelok unions containing septa into the outside nut. Solvent was injected into the system by inserting the hypodermic needle attached to a syringe through the septum such that the tip of the needle was at the middle of the inlet tube which carries the gas into the mixing chamber. Three motor-driven syringe pumps were used to drive solvent mixtures through syringes and into the system. Two Sage Instruments Model 341 pumps and one Harvard Apparatus Model 975 pump were used in

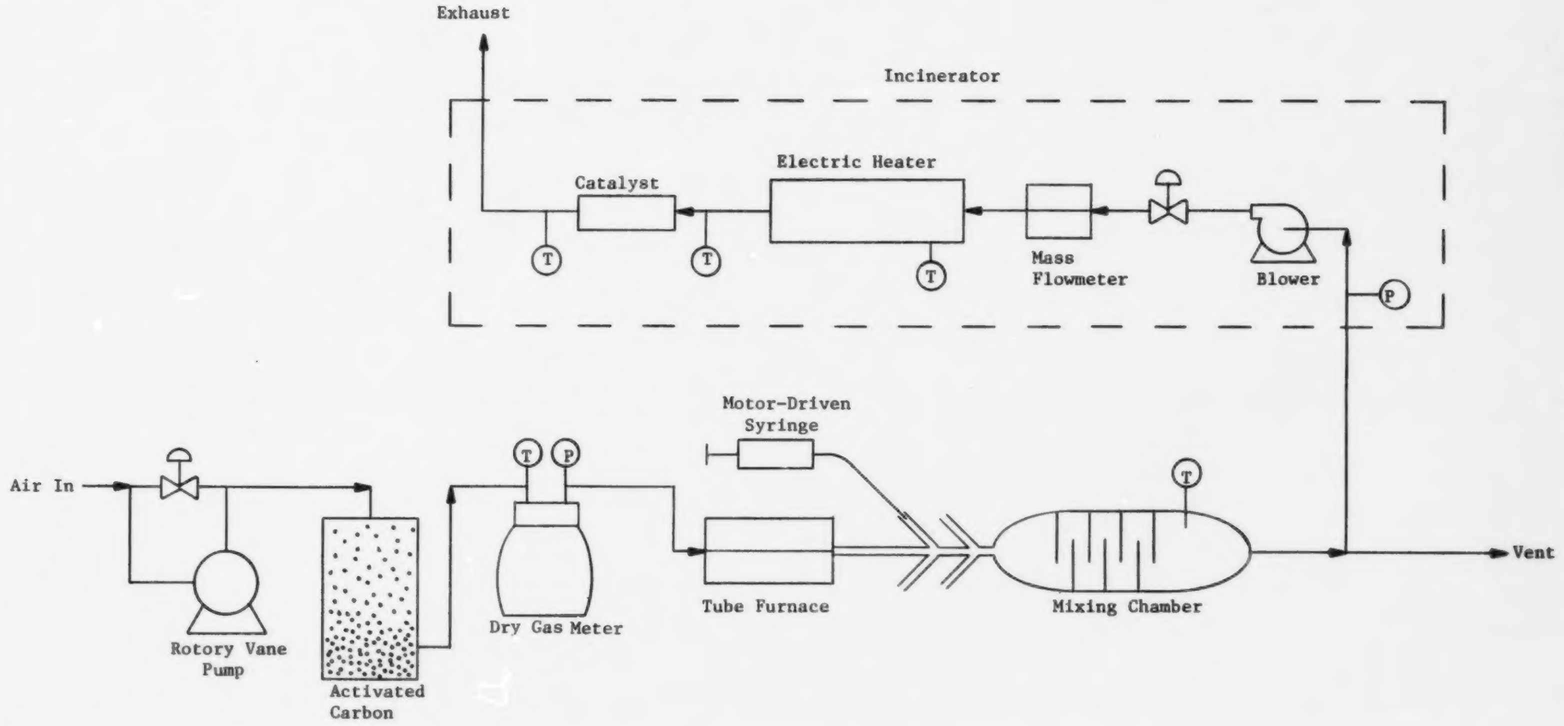
Exhaust
Incinerator
Catalyst
Electric Heater
T
T
T
Mass
Flowmeter
Blower
P
Motor-Driven
Syringe
Air In
T
P
T
Vent
Rotory Vane
Pump
Activated
Carbon
Dry Gas Meter
Tube Furnace
Mixing Chamber

FIGURE 3-2. INCINERATOR AND SOLVENT VAPOR GENERATION SYSTEM

conjunction with 10, 20, 30, 50, and 100 milliter glass syringes to deliver solvent mixtures at constant rates. After the solvent entered the system, it was flash vaporized by the heated airstream and heated walls of the inlet tube and was immediately delivered to the mixing chamber to produce a homogeneous mixture. The solvent vapor was then split between the incinerator inlet and an overflow or bypass vent according to the desired flowrate through the incinerator.

Desired concentrations of solvent vapors were prepared by varying the solvent flowrate while holding the gas flowrate in the vapor generation system constant. Two methods of changing solvent flowrates were available: changing the size of the syringe used and changing the drive rate on the syringe pump. An additional method which was used to provide exact desired flowrates involved using a combination of two syringes and syringe drives simultaneously. Syringes and syringe pumps were calibrated by timing the delivery of a measured amount (1-5 ml) of ethyl alcohol into volumetric flasks. Reproducible solvent flowrates were obtained for many syringe/driverate combinations over a range of 0.012 - 2.75 ml/min.

Limited tests were also conducted with solvent vapors injected into the system from gas cylinders. These solvents were metered into the vapor generation system with float-in-tube flow meters calibrated for the solvent vapor being delivered. During these tests, air entering the rotary vane pump was diluted with N_2 and CO_2 to produce a gas stream with approximately 86 percent N_2, 12 percent CO_2, 1.5 percent O_2 and 0.5 percent hydrocarbon. The N_2 and CO_2 were delivered to the pump inlet from liquid CO_2 and N_2 cylinders at rates of approximately 2.5 and 10 scfm, respectively.

A gas flowrate of approximately 12 acfm through the vapor generation system was employed for most testing. This flowrate was obtained by adjusting the bypass valve at the pump. Precise standard gas flowrates were determined frequently during each day of testing by timing the passage of a given volume (20 ft^3) of gas at the dry gas meter and making necessary corrections for temperature and pressure. System pressure, as measured at the dry gas meter, ranged from 25-50" H_2O. A change in catalysts and use of the incinerator system blower were the major causes of variation. Gas temperature at the outlet of the mixing chamber was maintained at approximately 225°F by means of the heating tapes and tube furnace. Maintenance of this outlet temperature provided adequate vaporization of solvent in the inlet tubing and prevented condensation in the system thereafter.

4.0 EXPERIMENTAL DESIGN

The technical objective of this program was to investigate, on an experimental scale, the effectiveness of catalytic oxidation as a means of destroying volatile organic compounds (VOC) and hazardous/toxic air pollutants (HAP). Achieving this broad objective required the selection of a wide range of incinerator operating conditions. In designing the experimental program, conditions were selected to (1) provide data on a large number of compound types, (2) give an indication of the operating conditions required for destruction efficiencies near 98 or 99 percent, and (3) represent operating conditions typically used in industrial catalytic applications.

Major operating parameters that were varied during the testing included catalyst inlet temperature, compound concentration, space velocity, compound type, catalyst geometry, and catalyst volume. Much of the testing was conducted to characterize compound destruction across the heater and catalyst bed as a "system." However, heater and catalyst destruction efficiencies were also measured separately at a large number of conditions. In all cases, both total mixture and individual species destruction efficiencies were determined.

Due to the large quantity and types of data collected, a review of the data and results could easily become unweildy. The purpose of this section is to first discuss the actual conditions selected for testing and second summarize the number and types of tests conducted. This section will then serve as background for the discussion of test results in Section 7.0.

4.1 TEST PARAMETERS

A large majority of the test work completed during this study involved the measurement of destruction efficiencies for low concentrations of

VOC/HAP mixtures in air. However, a short series of tests was conducted with a low oxygen gas stream, intended to simulate the off-gas from an ethylene oxide production process. The test parameters and conditions associated with each of these portions of the study are discussed separately in the sections below.

4.1.1 VOC/HAP Mixtures in Air

Test parameters and conditions for the VOC/HAP mixtures in air are shown in Table 4-1. A total of eleven multicomponent mixtures with between two and seven components each were tested. In addition, 16 of the mixture components were tested individually. Compounds in each of the eleven mixtures and those compounds tested individually are shown in Tables 4-2 and 4-3, respectively.

The total mixture concentration at the inlet to the incineration unit was typically maintained near 1,200 ppmC (parts per million by volume as carbon). However, several tests were conducted at 6,000 and 10,000 ppmC. Mixtures were generally prepared to provide equal amounts of each component on a carbon basis. Thus, a seven component mixture at a total inlet concentration of 1,200 ppmC would have approximately 170 ppmC of each component.

As shown in Table 4-2, the multicomponent mixtures represent solvents from a wide range of chemical classes. Mixture 1, which consisted of five compounds from different classes, was used as a control mixture. Replicate tests using this mixture were performed throughout the testing to provide estimates of variability within and between series of tests.

Mixtures 1A, 1B, and 1C were used to assist an analysis of mixture effects on destruction efficiency. These mixtures contain four of the compounds from Mixture 1 with either cyclohexane, iso-octane, or n-octane substituted for hexane. Tests conducted with the individual components listed in Table 4-3 were also used to assess the effects of mixture.

TABLE 4-1. TEST PARAMETERS AND CONDITIONS FOR VOC/HAP COMPOUNDS

Test Parameter	Conditions or Values Tested
VOC/HAP Mixture	8 multi-component mixtures and 16 single components[a]
Total Mixture Inlet Concentration (ppmC)[b]	10,000 6,000 1,200
Space Velocity	15,000 20,000 30,000 33,000 50,000 80,000
Catalyst Inlet Temperature (°F)	500 540 580 600 650 680 700 750 800
Catalyst Geometry/Volume (ft^3)[c]	Geometry A / 0.006 Geometry A / 0.012 Geometry B / 0.006

[a] Components in the tested mixtures are shown in Tables 4-2 and 4-3.

[b] This is the concentration at the inlet of the electric preheater.

[c] The larger catalyst was achieved by doubling the length of the catalyst while maintaining the same cross-sectional area.

TABLE 4-2. LISTS OF COMPONENTS IN MULTICOMPONENT VOC/HAP MIXTURES[a]

Mixture 1 - Control Mixture

Isopropanol
Methyl ethyl ketone
Ethyl acetate
Benzene
n-Hexane

Mixture 1A - Hexane Substitution

Isopropanol
Methyl ethyl ketone
Ethyl acetate
Benzene
Cyclohexane

Mixture 1B - Hexane Substitution

Isopropanol
Methyl ethyl ketone
Ethyl acetate
Benzene
Iso-octane

Mixture 1C - Hexane Substitution

Isopropanol
Methyl ethyl ketone
Ethyl acetate
Benzene
n-Octane

Mixture 2 - Industrial Mixture

Methyl ethyl ketone
Toluene

Mixture 3 - Alcohols/Acetates

Methanol
Ethanol
Isopropanol
n-Butanol
Ethyl acetate
n-Propyl acetate
Isobutyl acetate

Mixture 4 - Ketones/Miscellaneous Oxygenated Compounds

Acetone
Methyl ethyl ketone
Methyl isobutyl ketone
Cyclohexanone
Ethyl cellosolve
Butyl cellosolve
Dioxane

Mixture 5 - Aldehydes

Propionaldehyde
Isobutyl aldehyde
Isovaleraldehyde
n-butyl aldehyde
n-Valeraldehyde

Mixture 6 - Alkanes/Aromatics

n-Hexane
n-Octane
n-Decane
Benzene
Toluene
m-Xylene
Isopropyl benzene

Mixture 7 - Non-Chlorinated HAP's

m-Cresol
Acrylonitrile

Mixture 8 - Chlorinated HAP's

Methylene chloride
Carbon tetrachloride
Ethylene dichloride
Trichloroethylene
Tetrachloroethylene
1,1-Dichloroethane
1,1,2-Trichloroethane

TABLE 4-3. LIST OF SINGLE COMPONENTS TESTED

Mixture Designation	Compound
Mixture 9	Isopropanal
Mixture 10	Methyl ethyl ketone
Mixture 11	Ethyl acetate
Mixture 12	Benzene
Mixture 13	n-Hexane
Mixture 14	Cyclohexane
Mixture 15	Iso-octane
Mixture 16	n-Octane
Mixture 17	n-Butanol
Mixture 18	Isobutyl acetate
Mixture 19	Cyclohexanone
Mixture 20	Dioxane
Mixture 21	Propionaldehyde
Mixture 22	n-Decane
Mixture 23	Isopropyl benzene
Mixture 24	1,1-Dichloroethane

Mixture 2 was included in this study to represent a mixture encountered at an industrial site during an earlier full-scale incinerator test program.[1] Catalyst inlet temperatures, compound concentrations and space velocities similar to those observed for the full-scale system were tested on the pilot unit for comparison.

Mixtures 3 through 8 were selected to provide data on compounds in a large number of chemical classes, including:

- alcohols,
- acetates,
- ketones,
- other oxygenated compounds,
- aldehydes,
- alkanes,
- aromatics,
- non-chlorinated HAP's, and
- chlorinated HAP's.

Approximately half of the experimental program consisted of testing with these mixtures.

Space velocities, based on total catalyst volume and standard gas flowrate, were varied from 15,000 to 80,000 hr^{-1}. Industrial catalytic incineration units designed for 90 percent destruction typically have space velocities around 40,000 or 50,000 hr^{-1}.[1] Catalyst inlet temperatures were varied from 500° to 800°F, with the majority of tests conducted at 600°, 650°, 700°, and 800°F. Most catalytic incineration systems operate at inlet temperatures between 550° and 700°F.[1]

Two catalyst geometries, designated A and B, and two volumes of one geometry (catalyst A) were tested with the VOC/HAP compounds in air. Catalyst A represents the standard Torvex^{R} hydrocarbon abatement catalyst used in a wide range of industrial applications. Catalyst B has the same precious metals formulation as catalyst A, but on a substrate with higher surface area per unit volume. Other characteristics of the catalysts are discussed in Section 3.1.

The duration of the pilot-scale catalytic testing was approximately four months. No attempt was made during this period to assess the effect of catalyst operating life on destruction efficiency because the test period was too short and the operating conditions were too varied to be representative of a single industrial catalytic application. Data provided by one vendor on the typical operating life of catalysts applied in various industries is presented in Appendix D.

4.1.2 Low Oxygen, Ethylene Oxide Off-Gas

Assessing the effect of oxygen concentration on VOC/HAP destruction efficiencies required testing with a low oxygen (near stoichiometric) gas stream. In selecting a gas stream for simulation, a number of chemical processes were considered. The ethylene oxide production process was selected primarily because of successful application of catalytic oxidation to off-gases from this process in the past. Also, the molecular weight and chemical class of compounds in this off-gas offered additional information on the effect of compound type on destruction efficiency.

A detailed description of the air-oxidation ethylene oxide process is included in Appendix A of this report. Briefly the process involves the catalytic conversion of ethylene to ethylene oxide through a series of process steps involving reaction, adsorption, distillation, and condensation. The largest source of volatile organic compound emissions from the process is the main process vent stream. Catalytic incineration has been applied to the ethylene oxide process for the destruction of VOC emissions in this stream. The catalytic incinerator is typically used to convert ethylene (at 1 to 2 percent by volume) in the main process vent stream to CO_2 and water and to heat the gas from ambient temperature to up to 1,300°F at 100 to 200 psig.[2] This gas is then used to drive a gas turbine. A typical composition of the main process vent stream is shown in Table 4-4.

TABLE 4-4. GAS COMPOSITION OF MAIN PROCESS VENT FROM A TYPICAL AIR-OXIDATION PROCESS[a]

Component		Composition (Wt. %)	Composition (Volume %)
Ethylene oxide		0.02	0.01
Ethylene		0.80	0.85
Ethane		0.09	0.09
	Total VOC	0.91	0.95
Nitrogen		80.23	85.35
Oxygen		3.07	2.86
Carbon dioxide		15.65	10.60
Water		0.15	0.24
	Total	100	100

[a] References 3 and 4.

Test parameters and conditions for the ethylene oxide off-gas simulation are summarized in Table 4-5. Two stream compositions and two catalyst geometries were tested at space velocities of 30,000 and 50,000 hr^{-1} and catalyst inlet temperatures of 500° and 600°F. Comparison of the test gas compositions with the typical industrial composition in Table 4-4, shows that the simulated off-gases contained 25 and 50 percent less ethylene than the industrial gas. Lower ethylene concentrations were tested on the pilot unit because of materials and safety considerations. Complete adiabatic combustion of hydrocarbons in a gas stream with the composition shown in Table 4-4 would result in catalyst outlet temperatures near 1,200° or 1,300°F and operation of the pilot unit at this outlet temperature was not desirable.

A second difference between the simulated off-gas conditions and a typical industrial application is the incinerator operating pressure. The pilot-scale testing was conducted at atmospheric pressure and full-scale systems may operate at 100 to 200 psig. An analysis of the pressure effects on the ethylene oxidation reaction kinetics is provided in Appendix A. The results of this analysis indicate that the two major effects of pressure on the overall oxidation reaction cancel. Thus, destruction efficiencies measured at atmospheric pressure should be approximately the same as those obtained at 100 to 200 psig.

4.2 TEST MATRICES

The experimental portion for this program consisted of seven test series. The matrices for the seven series are presented in Tables 4-6 through 4-12 and are discussed in detail below.

Test Series A

In order to maximize the amount of performance data collected during the test program, the majority of testing was conducted using multicomponent

TABLE 4-5. TEST PARAMETERS AND CONDITIONS FOR ETHYLENE OXIDE OFF-GAS SIMULATION

Test Parameter	Conditions or Values Tested	
Stream Composition I (percent by volume)	Ethylene	0.43%
	Ethane	0.09%
	Ethylene oxide	0.01%
	Nitrogen	86.0%
	Carbon dioxide	12.0%
	Oxygen	1.5%
Stream Composition II (percent by volume)	Ethylene	0.64%
	Ethane	0.09%
	Ethylene oxide	0.01%
	Nitrogen	85.3%
	Carbon dioxide	11.5%
	Oxygen	2.5%
Space Velocity	30,000 hr^{-1} 50,000 hr^{-1}	
Catalyst Inlet Temperature	500°F 600°F	
Catalyst Geometry/Volume	Geometry A / 0.012 ft^3 Geometry B / 0.012 ft^3	

TABLE 4-6. MATRIX FOR TEST SERIES A

Test No.	VOC Mixture	Space Velocity (hr^{-1})	Mixture Inlet Concentration (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[a]
A-1[b]	1	50,000	6,000	580	A
A-2	13	50,000	1,200	580	A
A-3[c]	9	50,000	1,200	580	A
A-4	12	50,000	6,000	580	A
A-5[b]	1	50,000	6,000	580	A
A-6[c]	9	50,000	1,200	580	A
A-7	10	50,000	1,200	580	A
A-8	11	50,000	1,200	580	A
A-9	13	50,000	1,200	580	A
A-10[b]	1	50,000	6,000	580	A
A-11[c]	9	50,000	1,200	580	A
A-12	13	50,000	1,200	580	A
A-13	11	50,000	6,000	580	A
A-14	1	50,000	6,000	750	A
A-15	13	50,000	1,200	750	A
A-16[c]	9	50,000	1,200	750	A
A-17	12	50,000	1,200	750	A
A-18	1	50,000	6,000	750	A
A-19	10	50,000	1,200	750	A
A-20	11	50,000	1,200	750	A
A-21	12	50,000	6,000	750	A
A-22	11	50,000	6,000	750	A
A-23	13	50,000	6,000	750	A
A-24	13	50,000	1,200	750	A
A-25	14	50,000	1,200	750	A
A-26	14	50,000	6,000	750	A
A-27	1A	50,000	6,000	750	A
A-29	15	50,000	1,200	750	A
A-30	15	50,000	6,000	750	A
A-31	1B	50,000	6,000	750	A
A-32[b]	1	50,000	6,000	580	A
A-33	13	50,000	1,200	580	A
A-34	15	50,000	1,200	580	A
A-35	15	50,000	6,000	580	A
A-36	1B	50,000	6,000	580	A
A-37	16	50,000	1,200	580	A
A-38	1C	50,000	6,000	580	A
A-39	16	50,000	6,000	580	A
A-40	1	50,000	1,200	580	A
A-41	13	50,000	6,000	580	A
A-42	12	50,000	1,200	580	A
A-43[b]	1	50,000	6,000	580	A

[a] Catalyst volume was 0.006 ft^3.

[b] Control test replicates - Mixture 1.

[c] Control test replicates - Mixture 9.

TABLE 4-7. MATRIX FOR TEST SERIES B

Test No.	VOC Mixture	Space Velocity (hr^{-1})	Mixture Inlet Concentration (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[a]
B-1	1	50,000	6,000	500	A
B-2	1	50,000	1,200	500	A
B-3	1	80,000	6,000	540	A
B-4	1	33,000	6,000	540	A
B-5	1	80,000	1,200	580	A
B-6	1	33,000	1,200	580	A
B-7[b]	1	50,000	6,000	580	A
B-9	1	50,000	6,000	580	A
B-10[b]	1	50,000	6,000	580	A
B-11	1	80,000	6,000	680	A
B-12	1	33,000	6,000	680	A
B-13	1	80,000	1,200	680	A
B-14[b]	1	50,000	6,000	580	A
B-15	1	33,000	1,200	680	A
B-16	1	50,000	6,000	750	A
B-17	1	50,000	1,200	750	A

[a] Catalyst volume was 0.006 ft^3.

[b] Control test replicates.

TABLE 4-8. MATRIX FOR TEST SERIES C

Test No.[a]	VOC Mixture	Space Velocity (hr^{-1})	Mixture Inlet Concentration (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[b]
C-1	2	40,000	10,000	490	A
C-2	2	40,000	10,000	540	A
C-3	2	40,000	10,000	640	A
C-4[c]	1	50,000	1,200	600	A
C-5	3	20,000	1,200	650	A
C-6	3	30,000	1,200	700	A
C-7	3	30,000	1,200	600	A
C-8	3	50,000	1,200	700	A
C-9	3	50,000	1,200	800	A
C-10	3	50,000	1,200	600	A
C-11	17	50,000	1,200	600	A
C-12	18	50,000	1,200	600	A
C-13	4	50,000	1,200	600	A
C-14	4	50,000	1,200	700	A
C-15	4	30,000	1,200	700	A
C-16	4	30,000	1,200	600	A
C-17	4	20,000	1,200	650	A
C-18	4	50,000	1,200	800	A
C-19	19	50,000	1,200	600	A
C-20	20	50,000	1,200	600	A
C-21	1	50,000	1,200	600	A
C-22	5	20,000	1,200	650	A
C-23	5	30,000	1,200	700	A
C-24	5	30,000	1,200	600	A
C-25	5	50,000	1,200	700	A
C-26	5	50,000	1,200	800	A
C-27	5	50,000	1,200	600	A
C-28	21	50,000	1,200	600	A
C-29	5	20,000	1,200	600	A
C-30	5	30,000	1,200	650	A
C-31	5	50,000	1,200	650	A
C-32	6	20,000	1,200	650	A
C-33	6	30,000	1,200	700	A
C-34	6	20,000	1,200	600	A
C-35	6	30,000	1,200	650	A
C-36	6	50,000	1,200	800	A
C-37	6	50,000	1,200	600	A
C-38	22	50,000	1,200	600	A

TABLE 4-8. MATRIX FOR TEST SERIES C (Continued)

Test No.[a]	VOC Mixture	Space Velocity (hr^{-1})	Mixture Inlet Concentration (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[b]
C-39	23	50,000	1,200	600	A
C-40	6	50,000	1,200	650	A
C-41[c]	1	50,000	1,200	600	A
C-42	1	20,000	1,200	600	A
C-43	1	30,000	1,200	650	A
C-43H[a]	1	30,000	1,200	650	A
C-44	1	20,000	1,200	650	A
C-44H	1	20,000	1,200	650	A
C-45	1	30,000	1,200	700	A
C-45H	1	30,000	1,200	700	A
C-46	1	50,000	1,200	800	A
C-46H	1	50,000	1,200	800	A
C-47	1	20,000	1,200	600	A
C-47H	1	20,000	1,200	600	A
C-48	1	30,000	1,200	600	A
C-48H	1	30,000	1,200	600	A
C-49[c]	1	50,000	1,200	600	A
C-49H	1	50,000	1,200	600	A
C-50	1	50,000	1,200	700	A
C-50H	1	50,000	1,200	700	A
C-51	3	50,000	1,200	600	A
C-51H	3	50,000	1,200	600	A
C-52	3	30,000	1,200	600	A
C-52H	3	30,000	1,200	600	A
C-53	3	20,000	1,200	600	A
C-53H	3	20,000	1,200	600	A
C-54	3	50,000	1,200	800	A
C-54H	3	50,000	1,200	800	A
C-55	6	50,000	1,200	600	A
C-55H	6	50,000	1,200	600	A
C-56	6	30,000	1,200	600	A
C-56H	6	30,000	1,200	600	A
C-57	6	20,000	1,200	600	A
C-57H	6	20,000	1,200	600	A
C-58	6	50,000	1,200	700	A
C-58H	6	50,000	1,200	700	A
C-59	6	50,000	1,200	800	A
C-59H	6	50,000	1,200	800	A

TABLE 4-8. MATRIX FOR TEST SERIES C (Continued)

Test No.[a]	VOC Mixture	Space Velocity (hr^{-1})	Mixture Inlet Concentration (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[b]
C-60	5	50,000	1,200	600	A
C-60H	5	50,000	1,200	600	A
C-61	5	20,000	1,200	600	A
C-61H	5	20,000	1,200	600	A
C-62	5	50,000	1,200	800	A
C-62H	5	50,000	1,200	800	A
C-63	4	50,000	1,200	600	A
C-63H	4	50,000	1,200	600	A
C-64	4	20,000	1,200	600	A
C-64H	4	20,000	1,200	600	A
C-65	4	50,000	1,200	800	A
C-65H	4	50,000	1,200	800	A
C-66	7	20,000	1,200	600	A
C-66H	7	20,000	1,200	600	A
C-67	7	30,000	1,200	650	A
C-67H	7	30,000	1,200	500	A
C-68	7	20,000	1,200	650	A
C-69	7	30,000	1,200	700	A
C-70	8	20,000	1,200	650	A
C-70H	8	20,000	1,200	650	A
C-71	8	30,000	1,200	700	A
C-71H	8	30,000	1,200	700	A
C-72	8	20,000	1,200	600	A
C-73	8	30,000	1,200	600	A
C-73H	8	30,000	1,200	600	A
C-74	8	50,000	1,200	800	A
C-75	8	50,000	1,200	600	A
C-76	24	50,000	1,200	600	A
C-76H	24	50,000	1,200	600	A
C-78	8	50,000	1,200	650	A
C-79[c]	1	50,000	1,200	600	A
C-80	1	50,000	1,200	800	A

[a] Test numbers with "H" designation indicate destruction in heater only. Test numbers with no suffix indicate overall incinerator efficiency testing.

[b] Catalyst volume was 0.006 ft^3.

[c] Control test replicates.

TABLE 4-9. REVISED MATRIX FOR TEST SERIES D[a]

Test No.[a]	VOC Mixture	Space Velocity (hr^{-1})	Mixture Inlet Concentration (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[b]
D-1	1	30,000	1,200	600	B
D-2	1	30,000	1,200	700	B
D-3	1	50,000	1,200	800	B
D-3H	1	50,000	1,200	800	B
D-4	1	50,000	1,200	600	B
D-4H	1	50,000	1,200	600	B
D-5	1	50,000	1,200	700	B
D-5H	1	50,000	1,200	700	B
D-6	6	30,000	1,200	600	B
D-7	6	50,000	1,200	600	B
D-7H	6	50,000	1,200	600	B
D-8	6	30,000	1,200	700	B
D-9	6	50,000	1,200	700	B
D-9H	6	50,000	1,200	700	B

[a] Note: Runs C-42 through C-45 and C-66 through C-69 will serve as the Catalyst A portion of the matrix for Test Series D.

[b] Catalyst volume was 0.006 ft^3.

TABLE 4-10. MATRIX FOR TEST SERIES E

Test No.[a]	VOC Mixture	Space Velocity (hr^{-1})	Mixture Inlet Concentration (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[b]
E-1	1	50,000	1,200	600	A
E-1C	1	50,000	1,200	600	A
E-2	1	30,000	1,200	700	A
E-2C	1	30,000	1,200	700	A
E-3[c]	1	30,000	1,200	600	A
E-3C	1	30,000	1,200	600	A
E-4	1	30,000	1,200	800	A
E-4C	1	30,000	1,200	800	A
E-5	1	20,000	1,200	600	A
E-5C	1	20,000	1,200	600	A
E-6	1	20,000	1,200	700	A
E-6C	1	20,000	1,200	700	A
E-7	1	15,000	1,200	600	A
E-7C	1	15,000	1,200	600	A
E-8[c]	1	30,000	1,200	600	A
E-8C	1	30,000	1,200	600	A
E-9C	3	20,000	1,200	800	A
E-10	3	15,000	1,200	600	A
E-10C	3	15,000	1,200	600	A
E-11	3	20,000	1,200	700	A
E-11C	3	20,000	1,200	700	A
E-12[c]	1	30,000	1,200	600	A
E-12C	1	30,000	1,200	600	A
E-13C	4	30,000	1,200	800	A
E-14	4	15,000	1,200	600	A
E-14C	4	15,000	1,200	600	A
E-15	4	20,000	1,200	700	A
E-15C	4	20,000	1,200	700	A
E-16C	6	30,000	1,200	800	A
E-17	6	15,000	1,200	600	A
E-17C	6	15,000	1,200	600	A
E-18	6	20,000	1,200	700	A
E-18C	6	20,000	1,200	700	A
E-19C	1	50,000	1,200	800	A

[a] Test numbers with the "C" designation indicate destruction in the catalyst only. Test numbers with no suffix indicate overall incinerator efficiency testing.

[b] Same catalyst as used in Test Series A, B and C but with twice the volume or 0.012 ft^3.

[c] Control test replicates.

TABLE 4-11. MATRIX FOR TEST SERIES F

Test No.[a]	Space Velocity (hr^{-1})	Mixture Inlet Composition[b] (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[c]
F-1	50,000	I	500	B
F-1C	50,000	I	500	B
F-2C	50,000	I	600	B
F-3	30,000	I	600	B
F-3C	30,000	I	600	B

[a] Test numbers with the "C" designation indicate destruction in the catalyst bed only. Test numbers with no suffix indicate overall incinerator efficiency testing.

[b] Compositions for the ethylene oxide off-gases are presented in Table 4-5.

[c] Same catalyst as used in Test Series D but with twice the volume or 0.012 ft^3.

TABLE 4-12. MATRIX FOR TEST SERIES G

Test No.[a]	Space Velocity (hr^{-1})	Mixture Inlet Composition[b] (ppmC)	Inlet Temperature (°F)	Catalyst Geometry[c]
G-1	30,000	I	600	A
G-1C	30,000	I	600	A
G-2C	50,000	I	600	A
G-3	50,000	I	500	A
G-4	50,000	II	500	A

[a] Test numbers with the "C" designation indicate destruction in the catalyst bed only. Test numbers with no suffix indicate overall incinerator efficiency testing.

[b] Compositions for the ethylene oxide off-gases are presented in Table 4-5.

[c] Catalyst volume was 0.012 ft^3.

mixtures. Except for the simulated ethylene oxide off-gas, these mixtures were not designed to represent any particular industrial waste gas. Instead, compounds in the mixtures were selected on the basis of similarity in chemical classification and/or ease of speciation using Method 18. Test series A was designed to evaluate the potential effect of interactions between the various components in a multicomponent mixture, with respect to destruction efficiency of the individual components.

As shown in Table 4-6, the series A tests involved four multicomponent mixtures (Mixtures 1, 1A, 1B, and 1C) and eight single components (Mixtures 9 through 16). Compounds in these mixtures are shown in Tables 4-2 and 4-3. Each multicomponent mixture contained five compounds with the concentration of each component approximately one-fifth of the total mixture concentration. Tests were conducted at two concentrations and two catalyst inlet temperatures to allow separation of concentration and temperature effects from potential mixture effects. All tests involved determining overall system (heater plus catalyst) destruction efficiency at a single space velocity.

As indicated in Table 4-6, the test matrix included five runs using Mixture 1 at high concentration and four runs using one of the single components at low concentration (Mixture 9). This replication provided the between-run (i.e., run-to-run) precision estimate necessary to evaluate the statistical significance of any observed differences in destruction efficiencies.

Test Series B

The second series of tests (Table 4-7) was primarily a screening effort designed to allow selection of appropriate levels of space velocity, concentration and temperature for test series C through G. The screening effort included tests at three space velocities, two concentrations, and five temperatures. All tests were performed using the control mixture and the same catalyst used in series A. Data generated during this test series served as the primary bases for assessing the effect of inlet concentration on overall incinerator destruction efficiency. As shown in Table 4-7, the second test series included three test replicates to provide an estimate of precision.

Test Series C

The third test series consisted of parametric tests using seven different multicomponent VOC mixtures, in addition to replicate tests with the control mixture (Mixture 1). The majority of tests involved determining overall incinerator efficiencies, although heater destruction was measured at several conditions for each mixture. Test run numbers in Table 4-8 with the designation "H" indicate measurement of heater destruction efficiency.

Each of the VOC mixtures were tested at three space velocities and three or four catalyst inlet temperatures with the exception of Mixture 2. Tests on Mixture 2 were conducted at conditions intended to duplicate tests made on a full-scale incinerator during an earlier field test program. Only single concentrations of all eight VOC mixtures were tested.

Four replicate tests using the control mixture (Mixture 1) were interspersed between the other seven mixtures. Also, eight individual components were tested at a single space velocity and temperature to provide additional data on mixture effects.

Test Series D

The fourth series of incinerator tests was designed to provide a cursory evaluation of the effect of catalyst geometry on incinerator performance. Testing was performed with catalyst B using the control mixture and Mixture 6. The same space velocities and temperatures used for test series C were used in this series to allow direct comparison of the two catalyst geometries. Precision estimates for this series were based on control replicates from test series C.

Test Series E

The fifth test series was designed to provide data on catalyst A with twice the volume used in the first four test series. The change in the catalyst volume reduced solvent destruction in the heater and provided a better measure of catalyst destruction at low space velocities and high temperatures. Tests were performed with the control mixture at three space velocities and three catalyst inlet temperatures. The five test conditions showing the highest destruction efficiencies were then tested with three other VOC mixtures. Three replicate tests were performed with the control mixture to estimate precision.

Test run numbers in Table 4-7 with a "C" designation indicate measurement of catalyst bed destruction efficiency only.

Test Series F and G

These two series consisted of tests using two compositions of simulated ethylene oxide off-gas (see Table 4-5). Series F was performed with catalyst B and Series G was performed with catalyst A. Both catalysts had volumes of 0.012 ft^3. Two space velocities and two inlet temperatures were tested on each catalyst.

5.0 SAMPLING SYSTEM AND ANALYTICAL PROCEDURES

Gas samples were withdrawn from the catalytic incinerator at three locations: the inlet to the incinerator, the outlet of the incinerator electrical preheater, and the outlet of the incinerator after the catalyst bed. These gas streams were analyzed for organic compound composition by two independent methods and for carbon monoxide by a continuous instrumental method. The analyses were conducted to determine the destruction efficiency for organic solvents in the vapor phase. The fixed gas composition (CO_2, O_2 and N_2) of the incinerator inlet gas was also determined during certain testing. One gas sample was further analyzed by gas chromatography/mass spectrometry (GC-MS) to determine the identification and quantity of organic breakdown products produced by the catalytic incinerator.

5.1 SAMPLING SYSTEM

Gas samples were extracted from the incinerator at the three sampling points that were designated when the incinerator was designed and built. Each sampling location was incorporated into the incinerator using stainless steel Swagelok or NPT fittings which were easily converted to Swagelok fittings with a coupling. Heat-traced stainless steel tubing was used for all hydrocarbon sampling. Teflon tubing was employed for delivering gas samples to a Bendix Nondispersive Infrared (NDIR) carbon monoxide analyzer and a Fisher Model 1200 Gas Partitioner (for fixed gas analysis). Heated stainless steel metal bellows pumps were used to draw gas samples from the incinerator and deliver the gas to analytical instrumentation.

A schematic diagram of the initial sampling system design is provided in Figure 5-1. With this system, the incinerator inlet gas was always monitored for hydrocarbons with one Byron analyzer and one channel of the gas chromatograph (GC). A three-way valve was used to select either the

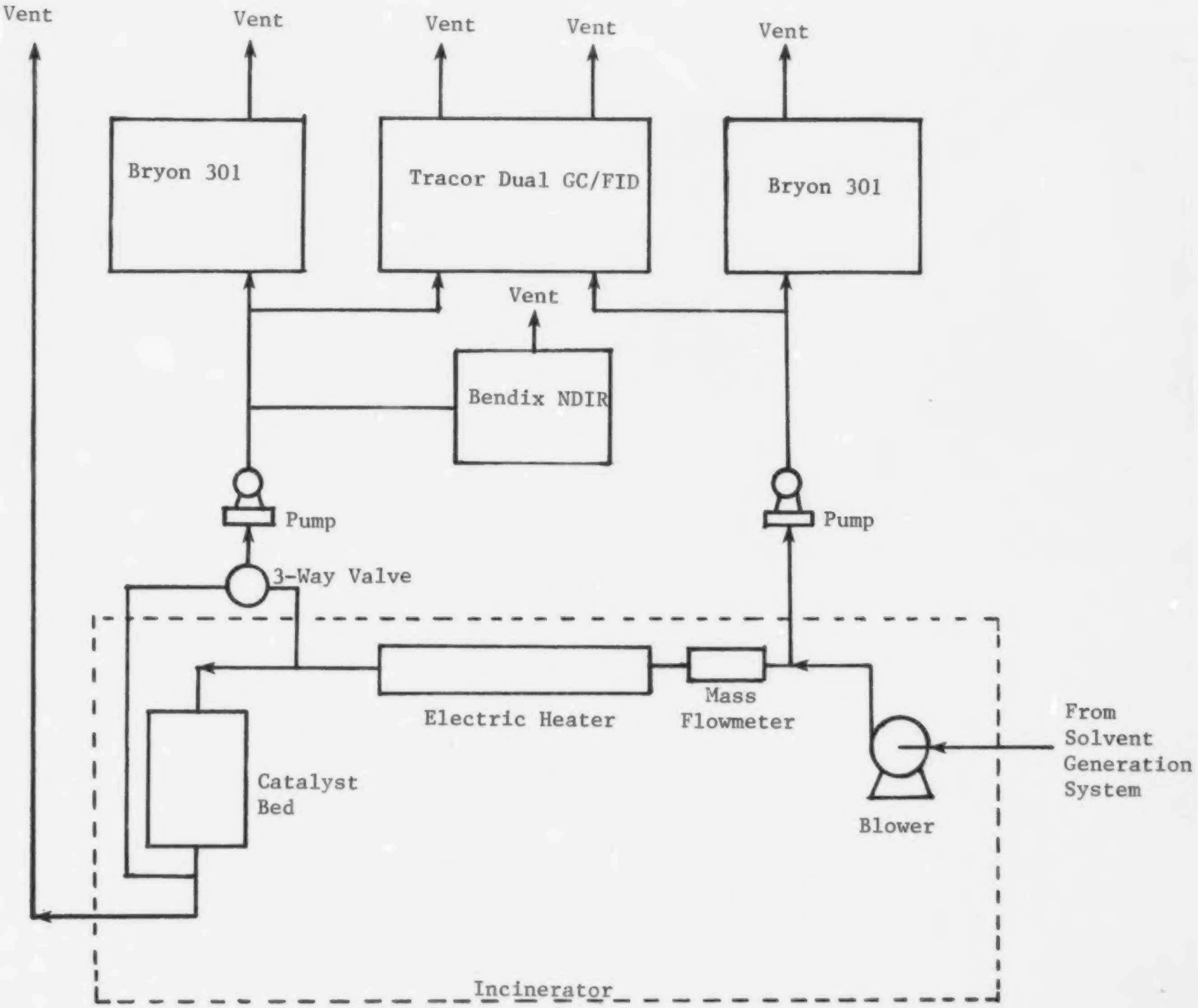
Vent
Vent
Vent
Vent
Vent
Bryon 301
Tracor Dual GC/FID
Bryon 301
Vent
Bendix NDIR
Pump
Pump
3-Way Valve
Electric Heater
Mass Flowmeter
From Solvent Generation System
Catalyst Bed
Blower
Incinerator

FIGURE 5-1. GAS SAMPLING SYSTEM

outlet of the heater or the outlet of the catalyst for the other gas stream analysis. This outlet gas stream was analyzed for hydrocarbons using a second Byron instrument, the second channel of the GC, and the Bendix NDIR gas analyzer for carbon monoxide.

The sampling system shown in Figure 5-1 was later modified to allow measurements at the heater outlet and the catalyst outlet simultaneously. With this system, the incinerator outlet gas was always analyzed for hydrocarbons and carbon monoxide. A three way valve was used to select either the incinerator inlet or the heater outlet for hydrocarbon analysis.

The gas sample for GC-MS analysis was obtained with a stainless steel canister at the incinerator outlet. Additional information about the GC-MS sampling is provided in Section 5.5.

5.2 EPA METHOD 18

Method 18 provides for individual organic specie quantitation by gas chromatography using a flame ionization detector (GC-FID). This analysis was automated for this study to provide multiple analyses of the same gas stream. A minimum of three to six analyses of each gas stream at a given set of test conditions were completed to provide adequate data for statistical analysis.

A Tracor Model 560 gas chromatograph equipped with two flame ionization detectors was used for the Method 18 analyses. The GC was equipped with two 8-port valves connected to a single solenoid-driven air actuator. Each 8-port valve was equipped with a fixed 2 ml. stainless steel gas sample loop for injecting fixed gas sample volumes into both GC channels. Parameters for GC analysis of all mixtures and retention times of all species are presented in Table 5-1.

TABLE 5-1. GC/FID PARAMETERS AND COMPONENT RETENTION TIMES

Mixture	Column	Carrier Gas Flow Rate (mℓ N_2/min)	Column Temperature Program	Component	Retention Time (min)
1	6ft x 1/8" SS, 1% SP1000 on 60/80 mesh Carbopack B	50	200° isothermal	Isopropanol	0.65
				Methyl ethyl ketone	.90
				Ethyl acetate	1.02
				Benzene	1.54
				n-Hexane	1.86
2	6ft x 1/8" SS, 1% SP1000 on 60/80 mesh Carbopack B	50	230° isothermal	Methyl ethyl ketone	0.77
				Toluene	2.50
3	6ft x 1/8" SS, 1% SP1000 on 60/80 mesh Carbopack B	50	initial: 120° for 2 min rate: 15°/min final: 220° for 0 min	Methanol	0.56
				Ethanol	.78
				Isopropanol	1.24
				n-Butanol	3.15
				Ethyl acetate	3.40
				n-Propylacetate	5.48
				iso-Butyl acetate	7.36
				Ethyl acetate	1.02
				Benzene	1.54
				n-Hexane	1.86
4	6ft x 1/8" SS, 1% SP1000 on 60/80 mesh Carbopack B	50	initial: 130° for 2 min rate: 15°/min final: 220° for 4 min	Acetone	1.06
				Methyl ethyl ketone	2.14
				Dioxane	2.70
				Ethyl cellosolve	3.96
				Cyclohexanone	5.63
				Methyl isobutyl ketone	5.87
				Butyl cellosolve	8.98

TABLE 5-1. (Continued)

Mixture	Column	Carrier Gas Flow Rate (mℓ N_2/min)	Column Temperature Program	Component	Retention Time (min)
5	6ft x 1/8" SS, 80/100 mesh Porapack Q	35	190° isothermal	Propionaldehyde	1.86
				n-Butylaldehyde	2.97
				isoButylraldehyde	3.43
				n-Valeraldehyde	5.86
				isoValeraldehyde	6.87
6	6ft x 1/8" SS, 10% TCEP on 80/100 Chromsorb PAW	50	90° isothermal	n-Hexane	0.67
				n-Octane	.80
				n-Decane	1.18
				Benzene	1.44
				Toluene	2.00
				p-Xylene	2.81
				isopropyl benzene	3.08
7	6ft x 1/8" SS, 1% SP1000 on 60/80 mesh Carbopack B	50	230° isothermal	Acrylonitrile	0.61
				m-Cresol	8.23
8	6ft x 1/8" SS, 1% SP1000 on 60/80 mesh Carbopack B	50	180° isothermal	Methylene chloride	0.67
				1,1-Dichloromethane	.92
				1,2-Dichloroethane	1.06
				Carbon tetrachloride	1.36
				Trichloroethylene	1.70
				1,1,2-Trichloroethane	1.93
				Tetrachloroethylene	3.96
Ethylene oxide off-gas	6ft x 1/8" SS, 60/80 mesh Porapack Q	20	Initial: 60°C for 3 min Rate: 60°/min Final: 150°C for 4 min	Ethylene	1.64
				Ethane	2.07
				Ethylene oxide	5.64

Two Hewlett Packard Model 3390A integrators were used to determine and record concentrations of individual species and to store calibration tables and integration parameters. A Convac Troll Model 300 programmable controller was used to automate this analysis by controlling events during each analysis cycle such as sample injection, start of integration and GC temperature programmer initiation.

Incinerator inlet and outlet gases were simultaneously analyzed with the dual channel GC/FID. Both gas streams from the gas manifolds were first passed through a single 8-port air-actuated valve. This valve was used to divert the gas streams toward or away from the sample loops and thus to stop gas flow through the sample loops prior to injection for temperature and pressure equilibration. After a one second equilibration time, gas sample valves were actuated to inject the gas contained in the sample loops onto the GC columns. At the same time, the integrators and GC temperature programmer (if necessary) were started. When all species were eluted from the column and the analysis was complete, both sampling valves and the flow diversion valve reset to their original positions to flush the sample loops with fresh sample gas. The integrators and temperature programmer all reset to their original conditions with internal timers to signal the end of the analysis.

An external standard method of calibration was employed for all Method 18 hydrocarbon determinations. This involves measuring the response indicated by the FID for known concentrations of given compounds and constructing a calibration curve from which unknown concentrations will be determined. Since this study involved many different organic compounds in various mixtures, commercially prepared standard gas mixtures were not obtained. Calibration gas mixtures were prepared dynamically using the same solvent vapor generation system used in preparing test mixtures (see Section 3.2). Five gas concentrations (including zero) were generated for initial calibrations of most test mixtures. The range of calibration included a point greater than the expected test mixture concentration and a point less than 1 percent of the expected test mixture concentration. Subsequent calibrations on each mixture usually included only two gas concentrations as long as the response factor agreed within 10 percent.

5.3 EPA METHOD 25A

Method 25A specifies that total hydrocarbon determinations be performed using a continuous monitor equipped with a FID. Although an FID was used with this method, monitoring was performed on a semi-continuous basis using two Byron Model 301 total hydrocarbon (THC) analyzers. These instruments are automated gas chromatographs which provide methane and nonmethane hydrocarbon (NMHC) concentrations for grab samples of gas taken during a continuous 3-minute cycle. Only the NMHC channels of the Byron instruments were calibrated and used during this program.

The Byron analyzer utilizes a hydrocarbon/air flame in the FID and zero grade air as the carrier gas. As each gas sample was automatically injected from the fixed sample loop, it first entered a packed chromatographic column which allowed methane to pass through it rapidly to the detector. After elution of methane, an automatically-switched valve reversed the flow through the column and all other components were backflushed to the detector. Electronic signals from the detector were amplified and stored until the end of each three-minute run. The integrated signal or area under the NMHC curve was obtained by a strip chart recorder and an Apple II computerized data acquisition system. The Apple II system converts the integrated areas into concentrations of hydrocarbons (ppmC) according to a calibration curve prepared at the beginning of each day.

The range of concentrations that the Byron 301 can measure is 0 to 20,000 ppmC. At the beginning of each day, a five-point calibration was accomplished. The range covered by the daily calibration was 0 to 10,000 ppmC, which included all actual hydrocarbon concentrations measured during testing. Commercially prepared standard gases were not obtained for all of the compounds and mixtures analyzed during the study. Rather, propane calibration mixtures were used for all nonmethane calibrations. These gases routinely serve as a reference point when determining concentrations of multiple-component gas streams or unknown composition streams.

5.4 CARBON MONOXIDE

Carbon monoxide was measured continuously on the incinerator outlet stream with a Bendix Model 8501-5B nondispersive infrared gas analyzer (NDIR). This instrument continuously draws sample gas through an impinger containing silica gel (to remove water) and into the sample cell. Carbon monoxide absorbs infrared light in the cell and this change in light transmittance is detected at the photo-electric detector. This signal is multiplied and delivered to a front panel analog meter and a strip chart recorder.

The Bendix NDIR is capable of measuring carbon monoxide concentrations in the range of 0-1000 ppm. Four full-scale ranges are available from a front-panel switch: 0-50, 0-250, 0-500, 0-1000. A four-point calibration was performed at the beginning of each day of testing using commercially prepared calibration gas mixtures. The range covered in each calibration was 0-60 ppm.

5.5 GC/MS

One incinerator outlet gas sample was further analyzed to determine the organic compounds formed from incomplete oxidation. The method of analysis chosen was GC/MS, which provides separation and identification of organic compounds. The gas grab sample was obtained by means of an evacuated stainless steel cannister. This was accomplished by connecting the cannister directly to stainless steel tubing at the catalyst outlet sampling location. The evacuated cannister was filled with sample gas in less than one minute.

In order to extract gas from the cannister, a measured amount of ultra high purity nitrogen was added to increase the pressure above atmospheric pressure. Due to the anticipated low concentrations of components, the gas sample was concentrated in a cryogenic trap using liquid oxygen. The sample was then flush vaporized onto the chromatographic column for separation and identification. Instrumentation conditions for the GC/MS analysis are presented in Table 5-2.

5.6 FIXED GASES

A Fisher Model 1200 Gas Partitioner was used to determine fixed gases (oxygen, carbon dioxide, nitrogen) in the incinerator inlet gas during tests with a high nitrogen concentration gas stream. Oxygen and carbon dioxide were determined with the Fisher Gas Partitioner and nitrogen was determined by difference.

The gas partitioner is a dedicated gas chromatograph designed specifically for this type of gas analysis. It employs a two-column system with detection by means of a thermal conductivity detector. Sample is introduced by flushing a fixed volume sample loop with test gas and manually turning a valve for injection of the gas into the chromatograph. The electrical signal from the detector is amplified and recorded on a strip-chart recorder. The operating parameters for the analysis were:

- Column 1: 1/8" x 6.5' aluminum packed with 80-100 mesh Columnpak PQ.
- Column 2: 3/16" x 11" aluminum packed with 60-80 mesh Molecular Sieve 13x.
- Oven temperature: 50°C
- Bridge Current: 225 mA
- Carrier Gas: 8.5% H_2 in He at 30 cc/min.

TABLE 5-2. GC-MS CONDITIONS FOR ANALYSIS OF CANISTER SAMPLE

GC-MS Conditions	
Instrument	Hewlett-Packard Model 5982
Ionization voltage	70 eV
Scan rate	1 scan/sec
Scan range	36 - 200 amu
Column	60 meter DB-5 Fused Silica wide bore thick film
Initial temperature	-50°C
Program rate	6°C/min
Final temperature	140°C
Interface	Open split coupled
Trap Conditions	
Cryogenic trap temperature	-183°C
Desorption temperature	190°C
Desorption time	>10 min

The gas partitioner was calibrated for nitrogen, carbon dioxide, and oxygen with commercially prepared calibration standards selected to bracket test concentrations. Due to frequent drift in the nitrogen analysis, nitrogen values measured during the testing were invalidated and nitrogen was instead determined by difference. Responses for calibration standards and samples were determined with a Hewlett Packard Model 3390A integrator. A three-point calibration for each compound was performed at the beginning of testing each day.

5.7 TEST SYSTEM OPERATING PARAMETERS

In addition to measuring VOC concentrations, carbon monoxide and fixed gases, a number of other system operating parameters were measured and recorded manually. These parameters and the measurements method used are listed in Table 5-3. Each of the parameters shown in Table 5-3 were measured at least once during each test run.

TABLE 5-3. OTHER SYSTEM OPERATING PARAMETERS RECORDED

Parameter	Test Method
Solvent injection temperature[a]	Thermocouple
Incinerator gas flowrate	Mass flowmeter
Catalyst inlet temperature	Thermocouple
Catalyst outlet temperature	Thermocouple
Main heater element temperature	Thermocouple
Catalyst shell temperature	Thermocouple
Solvent generation system gas flowrate	Dry gas meter
Dry gas meter temperature	Thermocouple
Dry gas meter static pressure	Magnahelic^R
Barometric pressure	Mercury barometer
VOC mixture addition rate	Metered volumetric addition
Catalyst bed pressure drop	Magnahelic^R

[a] This was the gas temperature at the outlet of the vapor generation system or inlet of the incinerator.

6.0 STATISTICAL METHODS

Statistical analyses were performed on results from this study to (1) assess the analytical variability in the destruction efficiencies measured at each test condition, and (2) test the hypothesis that observed differences in destruction efficiencies were due to parametric effects instead of random or analytical error.

Prior to conducting the statistical analyses, the raw analytical and process data were coded for entry into a data base for manipulation on the SAS system (5). SAS is a computer system designed for statistical analysis, which provides information storage and retrieval, data modification and programming, report writing, and file handling. Evaluation and interpretation of the pilot unit test results were performed using SAS general linear models routines.

The analysis of covariance (ANCOVA) technique was used to test the hypothesis that test parameters significantly influence destruction efficiency. A detailed discussion of this analysis technique is contained in Reference 6 (Brownlee, K. A.). The technique allows the effect of a single variable on destruction efficiency to be analyzed even though other parameters may also vary for the test runs being compared. For example, an accurate comparison of destruction efficiencies for two catalyst inlet temperatures may be difficult if inlet concentration and catalyst bed temperature rise were not the same for two test runs. However, through use of the ANCOVA technique, the average destruction efficiencies can be "adjusted" to approximate the destruction that would have been obtained if both measurements had been made at the same inlet concentration and temperature rise. In making the adjustments to the measured destruction efficiencies, the relationship between the covarates of inlet concentration and temperature and the dependent variable, destruction efficiency, was assumed to be linear. Scatter plots of the data indicate that this assumption is reasonable over the range of conditions tested. In order to determine whether measureable, or statistically significant, differences exist among the adjusted average destruction efficiencies, the ANCOVA separates the total variation that is present in the data into exclusive components and then tests hypotheses about those components. Statistical signficance was tested at both the 90 percent confidence level (indicating a marginal effect) and the 95 percent confidence level.

To provide an indication of analytical or measurement variability for the Method 18 data, the student's t distribution was used to estimate the 95 percent confidence interval for average destruction efficiencies. For the Method 25A data, a Monte-Carlo computer simulation method was used to generate confidence intervals for the mean THC destruction efficiency data. This method involved regenerating the average destruction efficiency 400 times. Each time, average inlet and outlet VOC concentrations were regenerated, except with an independent set of random variations. The distribution of the inlet and outlet VOC concentrations was approximated by a normal distribution. For each of the 400 trails, sample estimates of average inlet and outlet VOC concentration were computed. These estimates were then used to compute the average destruction efficiency. The 2.5 percent lower result and the 2.5 percent upper result from the 400 trails were then selected as the 95 percent confidence limits for the population mean destruction efficiency.

7.0 RESULTS OF TESTING AND ANALYSIS

Results from the pilot-scale catalytic incineration testing identified and/or verified the effects of a number of operating and design parameters on catalytic incinerator performance. Parameters found to have the greatest effect on destruction included catalyst inlet temperature, space velocity, compound type, catalyst geometry and catalyst volume. Other parameters generally showing a lesser effect included inlet concentration and mixture composition. The test results provided data on (1) potential partial oxidation products, (2) carbon monoxide emissions, and (3) catalyst temperature rise relationships. The capability of catalytic incineration to achieve destruction efficiencies in the 98 to 99 percent range was also verified for compounds in seven different chemical classes.

The results discussion presented in this section is divided into twelve parts:

7.1 Mixture Effects
7.2 Temperature and Space Velocity Effects
7.3 Relative Compound Destruction
7.4 Effect of Chlorinated Hydrocarbons
7.5 Effect of Catalyst Geometry
7.6 Effect of Inlet Concentration
7.7 Low Oxygen, Ethylene Oxide Off-Gas
7.8 Pilot vs. Full-Scale Data
7.9 GC/MS Results
7.10 Carbon Monoxide Emissions
7.11 Catalyst Bed Temperature Rise
7.12 Method 18 and Method 25A Comparison

Destruction efficiencies are based on inlet and outlet concentrations measured by Methods 18 and 25A. Method 18 concentrations were quanitated against compound specific standards prepared dynamically using the same solvent vapor generation system used to prepare test mixtures. Method 18 efficiencies showing a "greater than" (>) sign indicate that three or more mixture components in the outlet sample were below the detection limit. The Method 18 detection limits were 2.0 ppmC for a vast majority of the compounds tested. Some compounds, however, such as butyl cellosolve, had detection limits of 4.0 ppmC. Method 18 total hydrocarbon (THC) destruction efficiencies were determined using the sum of mixture component concentrations in the inlet and outlet streams.

Method 25A destruction efficiencies represent total non-methane hydrocarbon (NMHC) destruction. Inlet and outlet Method 25A concentrations were quanitated against propane standards. The outlet detection limit was 1.0 ppmC.

Confidence intervals presented in this section for destruction efficiences were based on the variation in individual concentration or destruction efficiency measurements during a particular test run. Usually a minimum of six samples were analyzed with both Method 25A and Method 18 at a given test condition. In some instances, a minimum of three samples were analyzed.

7.1 MIXTURE EFFECTS

Multi-component mixture effects on compound specific destruction efficiencies were evaluated by comparing pure compound destruction efficiencies with destruction efficiencies of these compounds as components of the VOC test mixtures. In addition, destruction efficiences for compounds tested in more than one mixture were compared. Mixture compositions and pure compounds tested during this study were discussed in Section 4.0, and are listed for reference in Tables 7-1 and 7-2.

TABLE 7-1. LISTS OF COMPONENTS IN MULTICOMPONENT VOC/HAP MIXTURES[a]

Mixture 1 - Control Mixture

- Isopropanol
- Methyl ethyl ketone
- Ethyl acetate
- Benzene
- n-Hexane

Mixture 1A - Hexane Substitution

- Isopropanol
- Methyl ethyl ketone
- Ethyl acetate
- Benzene
- Cyclohexane

Mixture 1B - Hexane Substitution

- Isopropanol
- Methyl ethyl ketone
- Ethyl acetate
- Benzene
- Iso-octane

Mixture 1C - Hexane Substitution

- Isopropanol
- Methyl ethyl ketone
- Ethyl acetate
- Benzene
- n-Octane

Mixture 2 - Industrial Mixture

- Methyl ethyl ketone
- Toluene

Mixture 3 - Alcohols/Acetates

- Methanol
- Ethanol
- Isopropanol
- n-Butanol
- Ethyl acetate
- n-Propyl acetate
- Isobutyl acetate

Mixture 4 - Ketones/Miscellaneous Oxygenated Compounds

- Acetone
- Methyl ethyl ketone
- Methyl isobutyl ketone
- Cyclohexanone
- Ethyl cellosolve
- Butyl cellosolve
- Dioxane

Mixture 5 - Aldehydes

- Propionaldehyde
- Isobutyl aldehyde
- Isovaleraldehyde
- n-butyl aldehyde
- n-Valeraldehyde

Mixture 6 - Alkanes/Aromatics

- n-Hexane
- n-Octane
- n-Decane
- Benzene
- Toluene
- m-Xylene
- Isopropyl benzene

Mixture 7 - Non-Chlorinated HAP's

- m-Cresol
- Acrylonitrile

Mixture 8 - Chlorinated HAP's

- Methylene chloride
- Carbon tetrachloride
- Ethylene dichloride
- Trichloroethylene
- Tetrachloroethylene
- 1,1-Dichloroethane
- 1,1,2-Trichloroethane

TABLE 7-2. LIST OF SINGLE COMPONENTS TESTED

Mixture Designation	Compound
Mixture 9	Isopropanal
Mixture 10	Methyl ethyl ketone
Mixture 11	Ethyl acetate
Mixture 12	Benzene
Mixture 13	n-Hexane
Mixture 14	Cyclohexane
Mixture 15	Iso-octane
Mixture 16	n-Octane
Mixture 17	n-Butanol
Mixture 18	Isobutyl acetate
Mixture 19	Cyclohexanone
Mixture 20	Dioxane
Mixture 21	Propionaldehyde
Mixture 22	n-Decane
Mixture 23	Isopropyl benzene
Mixture 24	1,1-Dichloroethane

All destruction efficiencies presented in this section represent total system (catalyst plus heater) destruction with 0.006 ft^3 of catalyst geometry A at a space velocity of 50,000 hr^{-1}.

Pure compound and component destruction efficiencies for the five compounds in Mixture 1 are shown in Table 7-3. Pure compound data in Table 7-3 were collected with system inlet concentrations of approximately 1,200 ppmC. Total mixture inlet concentrations were approximately 6,000 ppmC with each component at one-fifth of this concentration (or 1,200 ppmC). The analysis of covariance technique (ANCOVA) discussed in Section 6.0 was used to assess the effects of mixture on destruction efficiency. Mean destruction efficiencies were adjusted for (1) the variation in inlet concentration around the desired test condition of 1,200 ppmC and (2) the larger catalyst bed temperature rise occurring during the mixture tests (due to the higher total VOC concentration). The test for a statistically significant difference between destruction efficiencies was based on a 95 percent confidence interval generated for the adjusted mean values. If the confidence intervals did not overlap the effect of mixture was considered significant. If the intervals did overlap, no conclusion could be made regarding the presence or absence of an effect.

As shown in Table 7-3, all components except benzene showed a statistically significant effect of mixture at the lower temperature. Methyl ethyl ketone, ethyl acetate, isopropanol, iso-octane, and cyclohexane all showed lower destruction efficiencies as pure compounds than as mixture components. In contrast, n-hexane and n-octane showed higher pure compound destruction efficiencies than component destruction efficiencies.

Additional data comparing pure compound with mixture component destruction efficiencies are shown in Table 7-4. These data represent thirteen compounds from test Mixtures 3 through 6 and Mixture 8. Pure compound data in Table 7-4 were collected with system inlet concentrations of 1,200 ppmC, while component concentrations in the test mixtures were

TABLE 7-3. COMPARISON OF PURE COMPOUND AND COMPONENT DESTRUCTION FOR MIXTURE 1

Mixture Number	Component	Total Mixture Concentration[a] (ppmc)	Component Concentration[a] (ppmc)	Catalyst Temperatures		System Destruction Efficiency, %		Statistically Significant Difference ?
				Inlet (°F)	Outlet (°F)	Mean	Adjusted Mean[b]	
1	Benzene	5919	1174	582	735	91.3	91.3	No[c]
12		—	1031	581	640	90.3	90.4	
1	Methyl ethyl	5919	1198	582	735	91.1	91.9	Yes[d]
10	Ketone	—	1212	581	634	89.3	87.2	
1	Ethyl acetate	5919	1189	582	735	88.7	89.0	Yes
11		—	1209	581	630	78.4	77.5	
1	iso-Propanol	5919	1185	582	735	90.3	90.7	Yes
9		—	1244	581	644	87.7	87.0	
1	n-Hexane	5919	1172	582	735	81.7	81.8	Yes
13		—	1251	581	639	91.0	91.2	
1C	n-Octane	5683	1106	583	706	82.2	ND[e]	Yes
16		—	1339	583	611	96.9		
1	Benzene	6525	1294	751	875	92.4	92.2	No
12		—	1145	750	788	92.0	91.9	
1	Methyl ethyl	6525	1313	751	875	96.2	96.0	Yes
10	Ketone	—	1281	750	781	96.3	93.4	

TABLE 7-3. COMPARISON OF PURE COMPOUND AND COMPONENT DESTRUCTION FOR MIXTURE 1 (CONTINUED)

Mixture Number	Component	Total Mixture Concentration[a] (ppmc)	Component Concentration[a] (ppmc)	Catalyst Temperatures Inlet (°F)	Catalyst Temperatures Outlet (°F)	System Destruction Efficiency, % Mean	System Destruction Efficiency, % Adjusted Mean[b]	Statistically Significant Difference ?
1	Ethyl acetate	6525	1297	751	875	97.6	97.4	No[c]
11		—	1231	751	787	97.2	96.2	
1	iso-Propanol	6525	1293	751	875	95.8	95.8	Yes[f]
9		—	1351	749	785	95.5	94.4	
1	n-Hexane	6525	1329	751	875	87.1	86.9	Yes[d]
13		—	1299	749	789	93.7	93.8	
1E	iso-Octane	5736	1127	749	859	83.2	ND[e]	Yes
15		—	1369	749	790	80.2		
1A	Cyclohexane	6364	1302	755	877	89.2	ND	Yes
14		—	1175	752	794	86.0		

[a] Concentration at system inlet based on Method 18.

[b] Mean destruction efficiencies adjusted for concomittant variables (covariates) of inlet concentration and catalyst bed temperature rise..

[c] "No" indicates that no conclusion can be drawn regarding the presence or absence of a mixture effect.

[d] "Yes" indicates a 95 percent probability that the observed difference in destruction is due to a mixture effect.

[e] ND = not determined due to insufficient data.

[f] Significant at 90 percent confidence level only indicating a marginal effect of mixture.

TABLE 7-4. COMPARISON OF PURE COMPOUND AND COMPONENT DESTRUCTION FOR VARIOUS MIXTURES

Mixture Number	Component	Total Mixture Concentration[a] (ppmc)	Component Concentration[a] (ppmc)	Catalyst Temperatures Inlet (°F)	Catalyst Temperatures Outlet (°F)	System Destruction Efficiency, % Mean	System Destruction Efficiency, % Adjusted Mean[b]	Statistically Significant Difference ?
3	iso-Butylacetate	1299	181	599	629	85.7	87.3	No[c]
17	iso-Butylacetate	—	1184	599	627	87.2	85.8	
3	n-Butanol	1299	190	599	629	94.8	96.3	No
18	n-Butanol	—	1320	599	629	94.9	95.1	
3	iso-Propanol	1299	36	599	629	84.8	86.6	No
9	iso-Propanol	—	1244	581	639	87.7	86.4	
3	Ethylacetate	1299	181	599	629	84.0	84.7	Yes[d]
	Ethylacetate	—	1209	581	630	78.4	77.9	
4	Methylethyl ketone	1276	181	599	626	88.0	88.1	No
10	Methylethyl ketone	—	1212	581	634	89.3	89.2	
4	Cyclohexanone	1276	180	599	626	94.6	96.2	Yes
19	Cyclohexanone	—	1106	598	618	92.4	91.2	
4	Dioxane	1276	177	599	626	86.4	91.8	Yes
20	Dioxane	—	1239	598	623	93.3	88.0	
5	Propionaldehyde	891	177	598	629	90.4	92.0	No
21	Propionaldehyde	—	1215	598	626	94.8	93.3	

TABLE 7-4. COMPARISON OF PURE COMPOUND AND COMPONENT DESTRUCTION FOR VARIOUS MIXTURES (CONTINUED)

Mixture Number	Component	Total Mixture Concentration[a] (ppmc)	Component Concentration[a] (ppmc)	Catalyst Temperatures		System Destruction Efficiency, %		Statistically Significant Difference ?
				Inlet (°F)	Outlet (°F)	Mean	Adjusted Mean[b]	
6	Benzene	1147	164	598	626	89.4	90.8	No
12	Benzene	—	1031	581	640	90.3	89.5	
6	n-Hexane	1147	164	598	626	87.4	92.4	Yes
13	n-Hexane	—	1251	582	639	91.0	86.6	
6	n-Decane	1147	163	598	626	93.5	95.2	No[c]
22	n-Decane	—	1279	598	623	96.8	96.2	
6	iso-Propylbenzene	1147	165	598	626	88.6	90.3	Yes
23	iso-Propylbenzene	—	1124	598	628	83.7	82.6	
8	1,1-Dichloroethane	1112	157	597	600	52.7	54.4	Yes
24	1,1-Dichloroethane	—	1295	597	607	38.7	36.9	

[a] Concentration at system inlet based on Method 18.

[b] Mean destruction efficiencies adjusted for concomitant variable (covariate) of inlet concentration.

[c] "No indicates that no conclusion can be drawn ragarding the presence or absence of a mixture effect.

[d] "Yes" indicates a 95 percent probability that the observed difference in destruction is due to a mixture effect.

approximately 180 ppmC. Mean destruction efficiencies were again adjusted through a covariance analysis for differences in inlet concentration and catalyst temperature rise to allow a comparison of the pure compound and component destructions.

Results of the statistical analysis of data in Table 7-4 showed significant effects of mixture for six of the thirteen compounds considered. There are no apparent similarities in the compounds showing these effects. Three of the six compounds, isopropanol, methyl ethyl ketone and n-hexane, showed different effects in Mixtures 3 through 6 than in Mixture 1. For iso-propanol, no mixture effect was observed for the pure compound destruction efficiency compared to that measured for iso-propanol as a component of Mixture 3. However, as shown in Table 7-3, an effect was observed at the same inlet temperature for iso-propanol as a component of Mixture 1. Methyl ethyl ketone did not show an effect of mixture for Mixture 4 (Table 7-4), but did show an effect for Mixture 1 (Table 7-3).

For n-hexane, an effect of mixture was observed for both Mixtures 1 and 6. However, in the case of Mixture 6, the pure compound destruction was lower than the mixture component destruction, while for Mixture 1, the pure compound destruction was higher.

Based on the data in Tables 7-3 and 7-4, it appears that mixture does have an effect on compound destruction efficiency for certain compounds. In most cases, the effect of mixture will be to increase component destruction as compared to the pure compound destruction. This increase in destruction efficiency probably results from heat generated by the more easily destroyed compounds in the mixture. Combustion of these compounds at the front of the catalyst bed would provide a rapid increase in the catalyst or gas temperature, resulting ultimately in more complete combustion of other compounds in the mixture.

The presence of other compounds in the mixture, however, may also result in a decreased component destruction compared to the pure compound destruction. This effect was observed only for n-hexane in Mixture 1 and n-octane in Mixture 1C. The observed decrease in destruction of these compounds in particular is not readily explainable. However, the fact that this effect was not observed for iso-octane, which is a branched alkane with similar molecular weight, suggests that the cause is not generally related to compound diffusion or destructability, but instead relates somehow to the selectivity of this particular catalyst for compounds other than linear alkanes.

Data for compounds tested in more than one mixture are presented in Tables 7-5 and 7-6. The data in Table 7-5 show that substitution of various compounds for hexane in Mixture 1 had no effect on the destruction of iso-propanol, methyl ethyl ketone, ethyl acetate, or benzene. As shown in Table 7-6, statistically significant differences in destruction were measured for iso-propanol and n-hexane in Mixtures 1 and 3 and Mixtures 1 and 6, respectively. For iso-propanol, the difference in destruction was relatively small (approximately 1.4 percent absolute), and was observed only at a catalyst inlet temperature of 600°F. A statistically significant difference in destruction of n-hexane was also measured only at a catalyst inlet temperature of 600°F.

Based on the data in Tables 7-4 and 7-5, component destruction efficiencies for a given compound in different mixtures may vary with mixture composition. These effects will probably be greatest at lower catalyst inlet temperatures.

7.2 EFFECTS OF INLET TEMPERATURE AND SPACE VELOCITY

The effects of catalyst inlet temperature and space velocity on destruction efficiency are discussed in this section for two volumes of catalyst geometry A. The effects of temperature and space velocity on

TABLE 7-5. COMPARISON OF COMPONENT DESTRUCTION FOR SIMILAR MIXTURES

Mixture Number	Component	Total Mixture Concentration[a] (ppmc)	Component Concentration[a] (ppmc)	Catalyst Temperatures		System Destruction Efficiency, %		Statistically Significant Difference
				Inlet (°F)	Outlet (°F)	Mean	Adjusted Mean[b]	
1	Benzene	5919	1174	582	735	91.3	91.3	No[c]
1B		5632	1097	585	715	90.8	90.9	
1C		5683	1080	583	706	91.5	91.6	
1	Methyl ethyl	5919	1198	582	735	91.1	91.9	No
1B	Ketone	5632	1127	585	715	91.2	91.4	
1C		5683	1153	583	706	91.7	91.7	
1	Ethylacetate	5919	1189	582	735	88.7	89.0	No
1B		5632	1146	585	715	88.3	88.5	
1C		5683	1163	583	706	88.4	88.5	
1	iso-Propanol	5919	1185	582	735	90.3	90.1	Yes[d]
1B		5632	1125	585	715	89.5	89.8	
1C		5683	1182	583	706	91.1	91.2	
1	Benzene	6525	1294	751	875	92.4	92.2	No
1A		6364	1219	755	877	92.0	91.9	
1B		5736	1141	749	859	92.1	92.1	
1	Methyl ethyl	6525	1313	751	875	96.2	96.0	No
1A	Ketone	6364	1283	755	877	96.3	96.1	
1B		5736	1148	749	859	96.7	96.4	
1	Ethyl acetate	6525	1297	751	875	97.6	97.4	No
1A		6364	1279	755	877	97.5	97.3	
1B		5736	1164	749	859	97.9	97.8	
1	iso-Propanol	6525	1293	751	875	95.8	95.8	No
1A		6364	1281	755	877	95.8	95.7	
1B		5736	1156	749	859	96.0	95.9	

[a] Concentration at system inlet based on Method 18.

[b] Mean destruction efficiencies adjusted for concomittant variables of inlet concentration and catalyst bed temperature rise.

[c] "No" indicates that no conclusion can be drawn regarding the presence or absence of a mixture effect.

[d] "Yes" indicates a 95 percent probability that the observed difference in destruction is due to a mixture effect.

TABLE 7-6. COMPARISON OF COMPONENT DESTRUCTION IN DIFFERENT MIXTURES

Component	VOC Mixture	Total Mixture Concentration[a] (ppmc)	Component Inlet Concentration[a] (ppmc)	Catalyst Temperature[a] Inlet	Catalyst Temperature[a] Outlet	System Destruction Efficiency, % Mean	System Destruction Efficiency, % Adjusted Mean[b]	Statistically Significant Difference ?
iso-Propanol	1	1261	251	598	626	87.6	87.2	Yes[c,e]
	3	1299	186	599	629	84.8	84.8	
	1	1262	253	698	724	93.3	93.0	No[d]
	3	1261	186	699	724	91.6	91.8	
	1	1295	256	793	818	95.9	95.8	No
	3	1326	184	794	819	93.0	93.2	
Methyl ethyl ketone	1	1261	256	598	626	91.3	91.3	No
	4	1276	199	599	626	88.0	86.7	
	1	1262	258	698	724	95.2	95.9	No
	4	1234	187	701	724	92.6	91.6	
	1	1295	267	798	818	96.9	97.8	No
	4	1389	199	794	814	96.3	95.9	
Ethyl acetate	1	1261	258	598	626	88.0	87.6	No
	3	1299	187	599	629	84.0	86.6	
	1	1262	260	698	724	94.0	93.3	No
	3	1261	181	699	724	91.5	93.5	
	1	1295	258	798	818	>99.3	>97.7	No
	3	1326	193	794	819	>98.3	>99.8	
Benzene	1	1261	248	598	626	88.7	88.0	No
	6	1147	164	598	626	89.4	90.3	
	1	1262	247	698	724	90.3	89.7	No
	6	1044	149	697	721	90.1	91.2	
	1	1295	256	798	818	91.1	90.1	No
	6	1089	156	794	821	89.8	90.9	
n-Hexane	1	1261	249	598	626	73.6	74.1	Yes[e]
	6	1147	164	598	626	89.4	87.0	
	1	1262	245	698	724	80.6	81.0	No
	6	1044	149	697	721	91.2	90.6	
	1	1295	258	798	818	87.4	88.0	No
	6	1089	155	794	821	91.4	90.3	

[a] Concentration at system inlet based on Method 18.

[b] Mean destruction efficiencies adjusted for concomittant variables of inlet concentration and catalyst bed temperature rise.

[c] "No indicates that no conclusion can be drawn regarding the presence or absence of a mixture effect.

[d] "Yes" indicates a 95 percent probability that the observed difference in destruction is due to a mixture effect.

[e] Significant at 90 percent confidence level only indicating a marginal effect of mixture.

mixture destruction efficiencies are discussed in Section 7.2.1 and the effects on component destruction are discussed in Section 7.2.2. Data on system, heater, and catalyst destruction are presented.

7.2.1 Effects on Mixture Destruction

System destruction efficiencies for Mixture 1 and Mixtures 3 through 8 are shown in Table 7-7 for space velocities ranging from 20,000 to 80,000 hr^{-1} and catalyst inlet temperatures ranging from 500 to 800°F. These data were collected on the smaller volume (0.006 ft^3) of catalyst A.

The test results in Table 7-7 show an increasing trend in system destruction efficiency with increasing catalyst inlet temperature and decreasing space velocity. This result was as expected. The effect of catalyst inlet temperature on system destruction appears to be greatest at the higher space velocities and/or for system destruction efficiencies below approximately 95 percent. System destruction efficiencies of 98 percent or greater (based on Method 25A) were observed at one or more test conditions for all mixtures except Mixture 8.

Test Mixture 5, which consisted of five different aldehyde compounds, generally showed the highest system destruction efficiencies of the mixtures tested. Mixture 8, which contained seven chlorinated hydrocarbons, showed by far the lowest destruction. Test Mixtures 3 (alcohols and acetates), Mixture 4 (ketones and miscellaneous oxygenated compounds) and Mixture 7 (acrylonitrile and cresol) generally showed similar system destruction efficiencies, slightly below those of Mixture 5. Mixtures 1 and 6 (aromatic compounds and linear alkanes) also showed similar destruction efficiencies, generally averaging from 1 to 3 percent below those of Mixtures 3 and 4.

Test results from Table 7-7 for Mixture 1 and Mixtures 3 through 6 are shown graphically in Figures 7-1 through 7-5. Based on the Mixture 1 results in Figure 7-1, system destruction efficiency decreased considerably for the small volume of catalyst A at catalyst inlet temperatures below

TABLE 7-7. SYSTEM DESTRUCTION EFFICIENCIES FOR ALL MIXTURES WITH SMALL VOLUME CATALYST A

Run Number	VOC Mixture	Space Velocity (hr^{-1})	System Inlet Concentration[b] (ppmc)	Catalyst Temperatures Inlet (°F)	Catalyst Temperatures Outlet (°F)	System Destruction Efficiency, % (95% Confidence Interval) Method 25A	System Destruction Efficiency, % (95% Confidence Interval) Method 18
B-5	1	80,000	1,226	569	582	74.0 (72.8, 75.1)	71.5 (71.0, 71.9)
B-13	1	80,000	1,214	678	705	82.8 (76.5, 89.2)	84.2 (83.4, 84.9)
B-2	1	50,000	1,205	498	549	77.9 (76.9, 79.0)	75.4 (74.6, 76.3)
B-9	1	50,000	1,208	578	605	87.3 (86.8, 87.9)	85.9 (85.7, 86.2)
C-41	1	50,000	1,305	598	626	87.6 (86.5, 88.7)	86.2 (85.9, 86.4)
C-50	1	50,000	1,262	698	724	91.1 (90.7, 91.6)	90.8 (90.6, 91.0)
B-17	1	50,000	1,230	748	771	93.4 (93.1, 93.7)	93.4 (93.3, 93.5)
C-46	1	50,000	1,295	798	818	92.8 (90.9, 94.2)	94.1 (93.8, 94.5)
B-6	1	33,000	1,266	567	582	90.2 (89.8, 90.7)	90.2 (89.8, 90.6)
B-15	1	33,000	1,282	689	707	96.3 (96.2, 96.5)	96.2 (96.1, 96.2)
C-48	1	30,000	1,248	595	620	93.9 (93.7, 94.2)	93.6 (93.7, 94.2)
C-43	1	30,000	1,319	645	670	94.7 (94.4, 95.1)	95.1 (94.9, 95.2)
C-45	1	30,000	1,262	698	722	96.1 (95.9, 96.3)	96.0 (95.8, 96.1)
C-42	1	20,000	1,383	598	619	97.9 (NA)[c]	97.8 (97.6, 98.0)
C-44	1	20,000	1,328	648	664	99.3 (99.3, 99.4)	>99.1
C-10	3	50,000	1,283	600	631	88.7 (88.2, 89.2)	89.5 (88.8, 90.2)
C-8	3	50,000	1,261	699	724	93.7 (93.6, 94.5)	93.9 (93.6, 94.2)
C-9	3	50,000	1,219	798	821	97.1 (97.0, 97.2)	97.8 (97.6, 97.9)
C-7	3	30,000	1,139	598	621	96.6 (96.5, 96.8)	96.1 (95.8, 96.4)
C-6	3	30,000	1,227	699	719	99.0 (99.0, 99.1)	>99.1
C-53	3	20,000	1,267	601	618	98.9 (98.9, 99.0)	99.0 (98.6, 99.3)
C-5	3	20,000	1,267	648	661	99.7 (99.7, 99.7)	>99.4
C-13	4	50,000	1,259	599	626	90.2 (89.9, 90.7)	90.5 (89.4, 91.5)
C-14	4	50,000	1,234	701	724	94.4 (94.3, 94.5)	94.6 (94.4, 94.9)
C-18	4	50,000	1,244	798	811	96.3 (96.2, 96.4)	95.0 (94.7, 95.3)
C-16	4	30,000	1,187	598	619	96.9 (96.8, 97.0)	95.2 (94.9, 95.5)
C-15	4	30,000	1,330	705	719	98.6 (98.6, 98.7)	>97.7
C-57	4	20,000	1,109	598	618	98.1 (98.0, 98.3)	>98.0
C-17	4	20,000	1,311	648	659	99.7 (99.7, 99.7)	>98.2
C-27	5	50,000	898	598	632	93.0 (92.8, 93.4)	92.8 (92.5, 93.1)
C-31	5	50,000	997	649	679	93.8 (93.5, 94.1)	93.9 (93.2, 94.6)
C-25	5	50,000	956	698	723	94.2 (93.9, 94.6)	96.2 (95.9, 96.5)
C-26	5	50,000	909	789	816	95.5 (95.3, 95.7)	>97.1
C-24	5	30,000	903	598	622	95.9 (95.6, 96.2)	>97.5
C-30	5	30,000	915	648	671	98.1 (98.1, 98.3)	>97.7
C-23	5	30,000	825	698	717	98.5 (98.5, 98.6)	>98.7
C-29	5	20,000	896	598	616	99.4 (99.4, 99.5)	>98.4
C-22	5	20,000	836	658	660	99.2 (99.2, 99.4)	>98.8

TABLE 7-7. SYSTEM DESTRUCTION EFFICIENCES FOR ALL MIXTURES WITH SMALL VOLUME CATALYST A (CONTINUED)

Run Number	VOC Mixture	Space Velocity (hr^{-1})	System Inlet Concentration[b] (ppmc)	Catalyst Temperatures Inlet (°F)	Catalyst Temperatures Outlet (°F)	System Destruction Efficiency, % (95% Confidence Interval) Method 25A	System Destruction Efficiency, % (95% Confidence Interval) Method 18
C-37	6	50,000	1,178	598	626	87.6 (87.3, 88.0)	89.3 (88.6, 90.0)
C-40	6	50,000	1,166	648	675	87.6 (87.0, 88.1)	90.0 (89.5, 90.5)
C-58	6	50,000	1,044	697	721	90.6 (90.3, 90.9)	91.2 (90.9, 91.6)
C-36	6	50,000	1,118	798	823	96.0 (95.9, 96.2)	93.0 (92.8, 93.3)
C-56	6	30,000	1,151	595	618	94.1 (94.0, 94.3)	94.8 (94.7, 95.0)
C-35	6	30,000	1,200	648	675	94.8 (94.7, 95.1)	95.1 (95.0, 95.2)
C-33	6	30,000	1,151	698	724	95.7 (95.6, 95.9)	95.0 (94.4, 95.7)
C-34	6	20,000	1,203	599	622	97.8 (97.7, 98.0)	97.7 (97.5, 97.9)
C-32	6	20,000	1,155	648	665	99.1 (99.1, 99.3)	>98.5
C-67	7	30,000	1,131	649	672	97.3 (97.3, 97.5)	>98.0
C-69	7	30,000	939	699	720	97.4 (97.4, 97.6)	>97.7
C-66	7	20,000	1,103	600	618	98.3 (38.0, 43.4)	>98.6
C-68	7	20,000	907	648	660	98.9 (98.9, 99.1)	>97.6
C-75	8	50,000	1,112	597	600	0.0 (-7.6, 6.9)	14.3 (8.9, 19.6)
C-78	8	50,000	1,170	649	653	7.4 (NA)[c]	18.0 (15.9, 20.1)
C-74	8	50,000	1,361	793	800	20.1 (16.4, 23.6)	52.5 (51.0, 53.9)
C-73	8	30,000	1,197	599	602	0.0 (-15.4, 8.2)	8.3 (2.0, 14.6)
C-71	8	30,000	1,296	698	706	33.2 (31.1, 35.2)	55.1 (52.4, 57.8)
C-72	8	20,000	1,232	603	699	59.1 (55.5, 62.7)	60.4 (55.6, 65.2)
C-70	8	20,000	1,285	640	648	78.7 (77.1, 80.3)	80.8 (79.5, 82.1)

[a] Catalyst volume was 0.006 ft^3.

[b] Total concentration at system inlet based on Method 18.

[c] NA = not available.

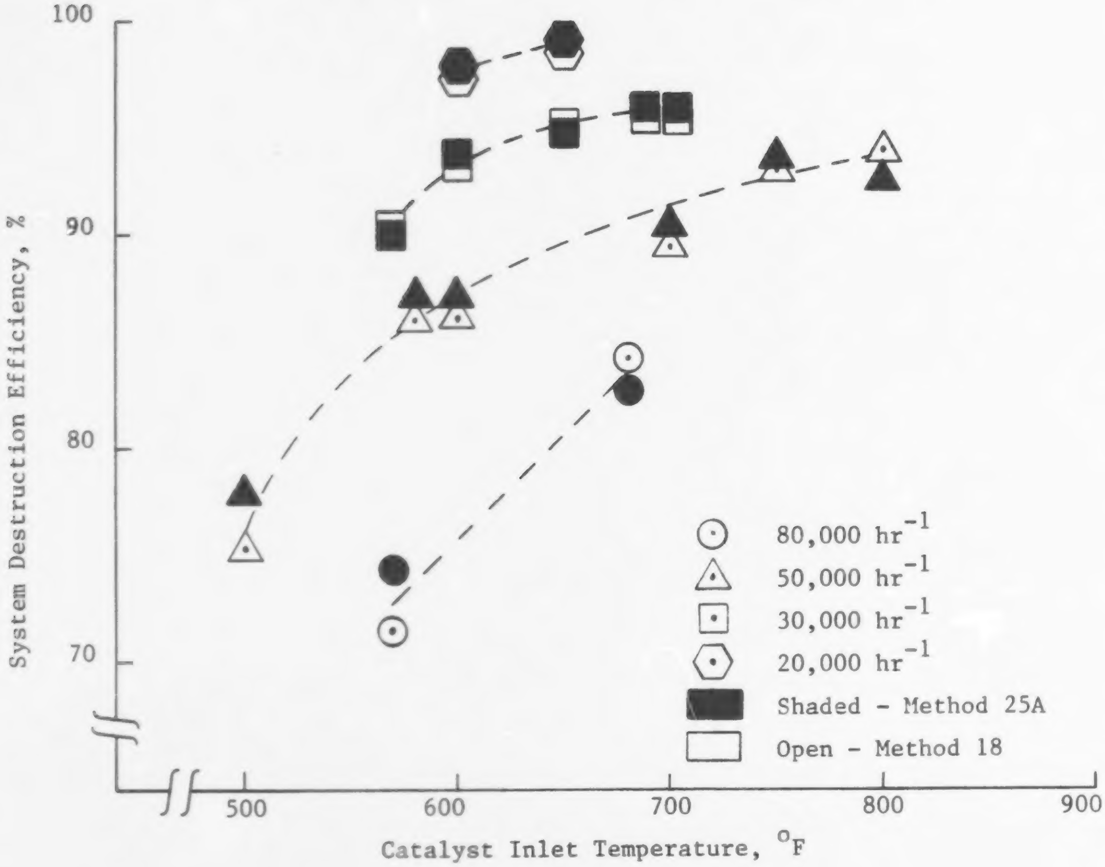

Figure 7-1. Mixture 1 system destruction efficiency vs. inlet temperature for small volume catalyst A.

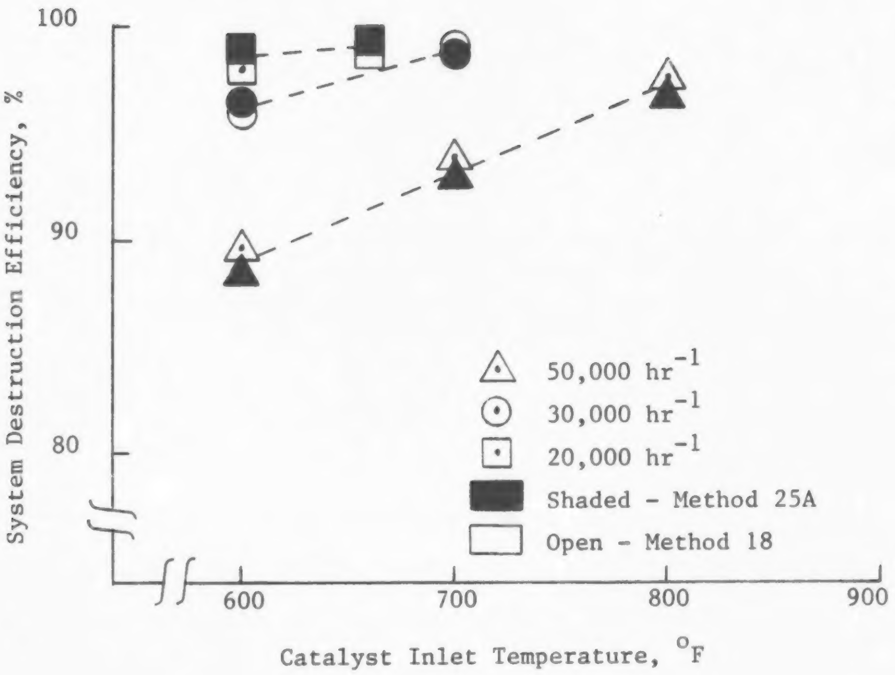

Figure 7-2. Mixture 3 system destruction efficiency vs. inlet temperature for small volume catalyst A.

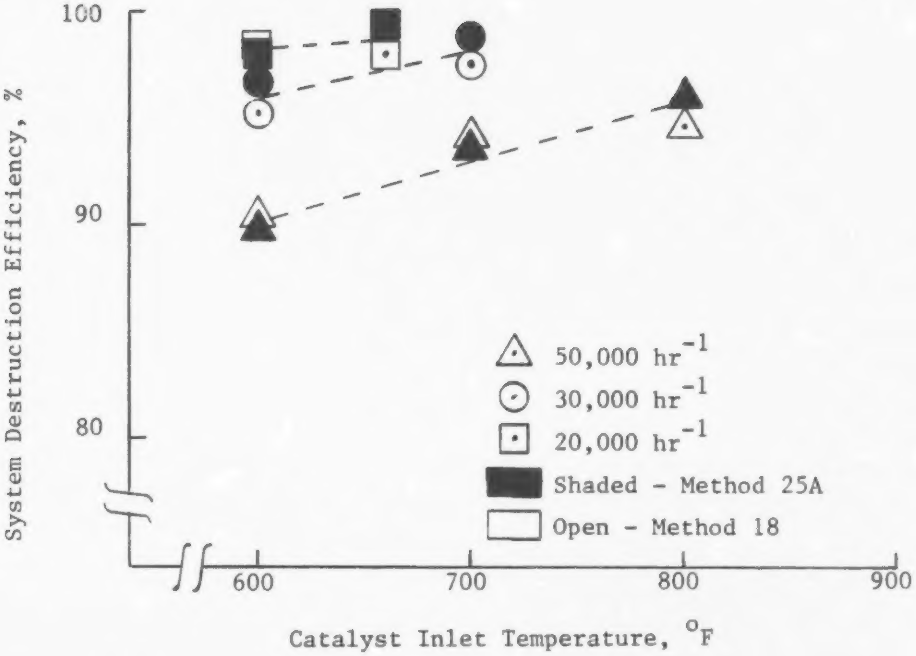

Figure 7-3. Mixture 4 system destruction efficiency vs. inlet temperature for small volume catalyst A.

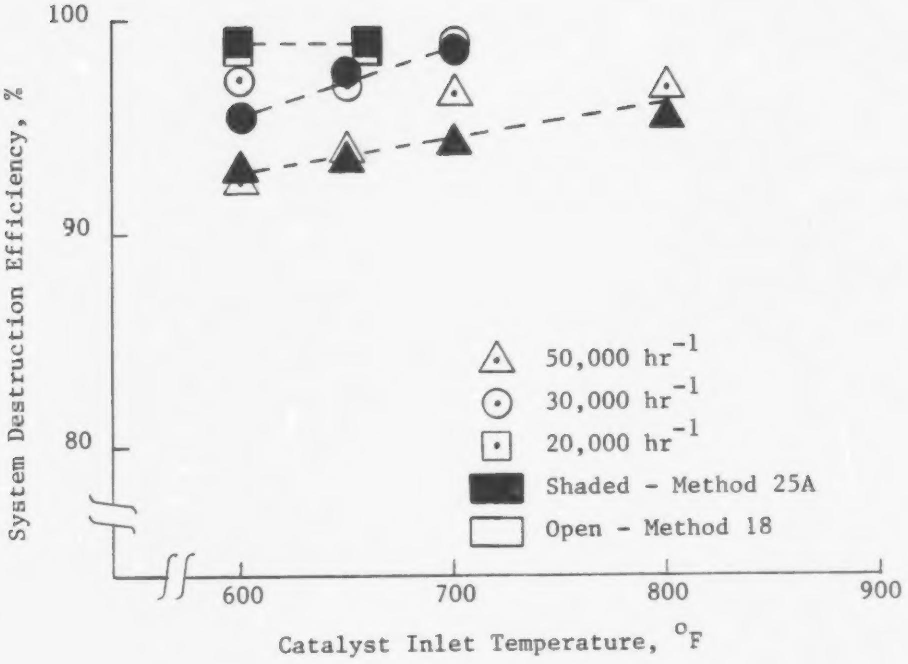

Figure 7-4. Mixture 5 system destruction efficiency vs. inlet temperature for small volume catalyst A.

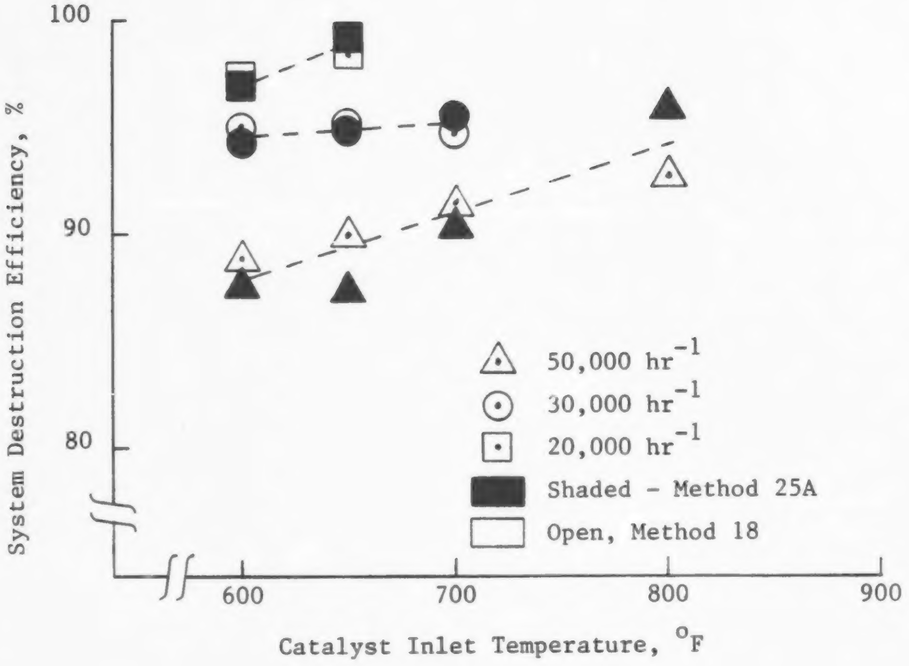

Figure 7-5. Mixture 6 system destruction efficiency vs. inlet temperature for small volume catalyst A.

600°F and space velocities between 50,000 and 80,000 hr^{-1}. Comparison of the data in Figures 7-2 through 7-5 indicates that system destruction efficiencies for Mixture 3 show a particularly strong dependence on catalyst inlet temperature at a space velocity of 50,000 hr^{-1}. In addition, system destruction efficiencies for Mixtures 3 and 6 show a strong dependence on space velocity.

System destruction efficiencies for the larger volume (0.012 ft^3) of catalyst A are presented in Table 7-8 for Mixtures 1, 3, 4 and 6. Mixtures 5, 7 and 8 were not tested with this volume of catalyst. The data in Table 7-8 also show destruction efficiencies of 98 percent or greater for each of the test mixtures, with similar trends of increased destruction at higher temperatures and lower space velocities.

System destruction efficiencies for Mixture 1 with the two volumes of catalyst A are compared in Table 7-9. The limited amount of data show higher system destruction efficiencies for the larger catalyst volume at three of the four test conditions. Also, as the system destruction efficiency increases, the difference between efficiencies for the two catalyst volumes becomes consistantly smaller. The reasons for the difference in system destruction for the two catalyst volumes will be discussed following a review of the heater and catalyst destruction.

Heater destruction efficiencies measured during the small volume catalyst A tests are shown in Table 7-10 for Mixtures 1 and 3 through 8. As shown in Table 7-10, heater destruction varied widely during the tests, with the highest efficiencies in the 80 to 90 percent range. In general, destruction in the heater increased with increasing catalyst inlet temperature and decreasing space velocity.

The high heater destruction efficiencies at high catalyst inlet temperatures and low space velocities resulted from thermal destruction. As discussed in Section 3.1, the heater on the pilot unit consists of a pipe or

TABLE 7-8. SYSTEM DESTRUCTION EFFICIENCIES FOR LARGE VOLUME CATALYST A

Run Number	VOC Mixture	System Inlet Concentration[b] (ppmc)	Space Velocity (hr^{-1})	Catalyst Temperature Inlet °F	Catalyst Temperature Outlet °F	System Destruction Efficiency, % (95% Confidence Level) Method 25A	System Destruction Efficiency, % (95% Confidence Level) Method 18
E-1	1	1374	50,000	597	631	92.0 (91.8, 92.3)	93.3 (93.1, 93.6)
E-3	1	1233	30,000	600	627	95.8 (95.6, 96.0)	95.5 (95.3, 95.7)
E-2	1	1311	30,000	698	717	97.7 (97.5, 97.9)	>98.0
E-4	1	1336	30,000	798	812	98.6 (98.5, 98.7)	>98.7
E-5	1	1253	20,000	600	617	97.6 (97.5, 97.8)	>97.7
E-6	1	1271	20,000	699	706	98.4 (98.3, 98.6)	>98.8
E-11	3	910	20,000	699	704	99.6 (99.6, 99.7)	>98.7
D-10	3	1235	15,000	600	606	99.7 (99.7, 99.7)	>98.9
E-15	4	1268	20,000	697	705	99.2 (99.1, 99.3)	>98.9
E-14	4	1278	15,000	595	608	99.0 (99.0, 99.1)	>98.9
E-18	6	1106	20,000	697	710	98.8 (98.8, 98.9)	>97.9
E-17	6	1123	15,000	602	616	98.9 (98.8, 98.9)	>97.7

[a] Catalyst volume was 0.012 ft^3.

[b] Total concentration at system inlet based on Method 18.

TABLE 7-9. EFFECT OF CATALYST VOLUME ON MIXTURE 1 DESTRUCTION

Run Number	VOC Mixture	Catalyst Volume (ft3)	Space Velocity (hr^{-1})	System Inlet Concentration[a] (ppmc)	Catalyst Temperatures Inlet (°F)	Catalyst Temperatures Outlet (°F)	System Destruction Efficiency, % (95% Confidence Interval) Method 25A	System Destruction Efficiency, % (95% Confidence Interval) Method 18
C-41	1	0.006	50,000	1,305	598	626	87.7 (86.5, 88.7)	86.2 (85.9, 86.4)
E-1	1	0.012	50,000	1,374	597	631	92.0 (91.8, 92.3)	93.3 (93.1, 93.6)
C-48	1	0.006	30,000	1,248	595	620	93.9 (93.7, 94.2)	93.6 (93.7, 94.2)
E-3	1	0.012	30,000	1,233	600	627	95.8 (95.6, 96.0)	95.5 (95.3, 95.7)
C-45	1	0.006	30,000	1,262	698	722	96.1 (95.9, 96.3)	96.0 (95.8, 96.1)
E-2	1	0.012	30,000	1,311	698	717	97.7 (97.5, 97.9)	>98.0
C-42	1	0.006	20,000	1,383	698	619	97.9 (NA)[b]	>97.6
E-5	1	0.012	20,000	1,235	600	617	97.6 (97.5, 97.8)	>97.7

[a] Total concentration at system inlet based on Method 18.

[b] NA = not available.

TABLE 7-10. HEATER DESTRUCTION EFFICIENCIES FOR VARIOUS MIXTURES WITH SMALL VOLUME CATALYST A

Run Number	VOC Mixture	Space Velocity (hr^{-1})	System Inlet Concentration[b] (ppmc)	Catalyst Temperatures Inlet (°F)	Catalyst Temperatures Outlet (°F)	Heater Destruction Efficiency, % (95% Confidence Interval) Method 25A	Heater Destruction Efficiency, % (95% Confidence Interval) Method 18
C-49H	1	50,000	1,270	598	624	22.7 (19.9, 25.8)	23.5 (19.8, 27.2)
C-50H	1	50,000	1,265	698	724	36.2 (33.2, 39.0)	31.8 (30.7, 32.9)
C-46H	1	50,000	1,295	798	818	29.8 (26.5, 33.2)	47.0 (45.6, 48.4)
C-48H	1	30,000	1,250	595	620	40.5 (36.5, 44.0)	39.7 (38.5, 41.0)
C-43H	1	30,000	1,320	645	670	33.0 (28.3, 37.1)	47.8 (45.8, 49.7)
C-45H	1	20,000	1,265	698	722	36.8 (31.6, 41.1)	55.4 (52.4, 58.4)
C-47H	1	20,000	1,383	598	619	46.8 (37.3, 53.9)	59.5 (58.2, 60.9)
C-44H	1	20,000	1,330	648	664	73.5 (72.0, 74.8)	86.5 (85.9, 87.1)
C-51H	3	50,000	1,315	598	627	17.7 (14.9, 20.2)	32.6 (22.8, 42.4)
C-54H	3	50,000	1,433	790	816	50.6 (47.6, 53.3)	73.2 (71.2, 75.1)
C-52H	3	30,000	1,537	599	622	46.0 (43.6, 48.8)	60.3 (57.9, 62.7)
C-53H	3	20,000	1,507	601	618	70.7 (69.0, 72.5)	87.6 (86.0, 89.2)
C-63H	4	50,000	1,292	598	626	21.3 (19.2, 23.4)	39.8 (38.0, 41.6)
C-65H	4	50,000	1,531	790	817	50.0 (44.8, 54.9)	65.7 (64.8, 66.7)
C-64H	4	20,000	1,321	598	618	66.1 (64.5, 67.6)	79.0 (76.6, 81.3)
C-60H	5	50,000	884	597	626	26.4 (23.1, 29.9)	39.9 (35.3, 44.5)
C-62H	5	50,000	847	795	818	54.1 (52.8, 56.9)	67.9 (67.3, 68.4)
C-61H	5	20,000	787	598	614	70.1 (68.6, 71.6)	78.3 (76.9, 79.6)
C-55H	6	50,000	1,116	598	625	22.9 (20.2, 25.8)	34.3 (32.6, 36.0)
C-59H	6	50,000	1,060	790	818	37.5 (34.9, 40.0)	40.6 (36.9, 44.3)
C-56H	6	30,000	1,151	595	619	29.6 (27.4, 31.7)	36.1 (34.6, 37.7)
C-57H	6	20,000	1,110	598	618	40.3 (38.0, 43.4)	60.6 (59.3, 61.9)
C-66H	7	20,000	1,085	600	618	40.7 (37.8, 43.7)	63.7 (44.5, 83.0)
C-73H	8	30,000	1,197	599	602	~0 (-15, -0.2)	2.4 (-1.2, 6.0)
C-71H	8	30,000	1,296	698	706	18.9 (14.5, 23.4)	49.9 (48.9, 50.9)
C-70H	8	20,000	1,285	640	648	43.7 (40.1, 47.1)	80.4 (79.1, 81.2)

[a] Catalyst volume was 0.006 ft^3.

[b] Total concentration at system inlet based on Method 18.

tube wrapped with a high temperature electrical resistance heater element. Achieving the higher catalyst inlet temperatures required operation of the heater element at temperatures in the range of 1,000 to 1,200°F. At low space velocities, or low system gas flow rates, the gas residence time in the heater was longer and the thermal destruction of solvent on the walls of the heater tube increased. The effect of heater element temperature on heater destruction efficiency is shown in Figure 7-6 for Mixtures 1 and 3 through 6. The data in Figure 7-6 are based on Method 25A results for a space velocity of 50,000 hr^{-1}.

The degree to which the heater destruction efficiencies observed for the smaller catalyst volume tests may represent heater or burner zone destruction efficiencies on full-scale catalytic incinerators is not known. Most full-scale catalytic incinerators requiring waste gas preheat will employ natural gas burners instead of resistance heaters. The design of these burners may vary considerably. In some cases, a portion of the waste gas will pass directly through the flame zone, providing an opportunity for a significant amount of compound destruction. However, other designs may not provide direct contacting of the waste gas with the flame. Heater destruction for this type of design would likely be small, if not negligible.

Tests with the larger catalyst volume showed considerably lower heater destruction efficiencies as shown in Table 7-11. Heater destruction was reduced with the larger catalyst volume because the system gas flowrate doubled for any given space velocity. The increase in gas flowrate halved the residence time of gas in the resistance heater. Also, the increased gas flow through the heater tube increased turbulence and improved heat transfer, thus reducing the heater element temperature required to achieve a given catalyst inlet temperature.

Catalyst destruction efficiencies for the smaller volume of catalyst A are shown in Table 7-12. These efficiencies were estimated from system and

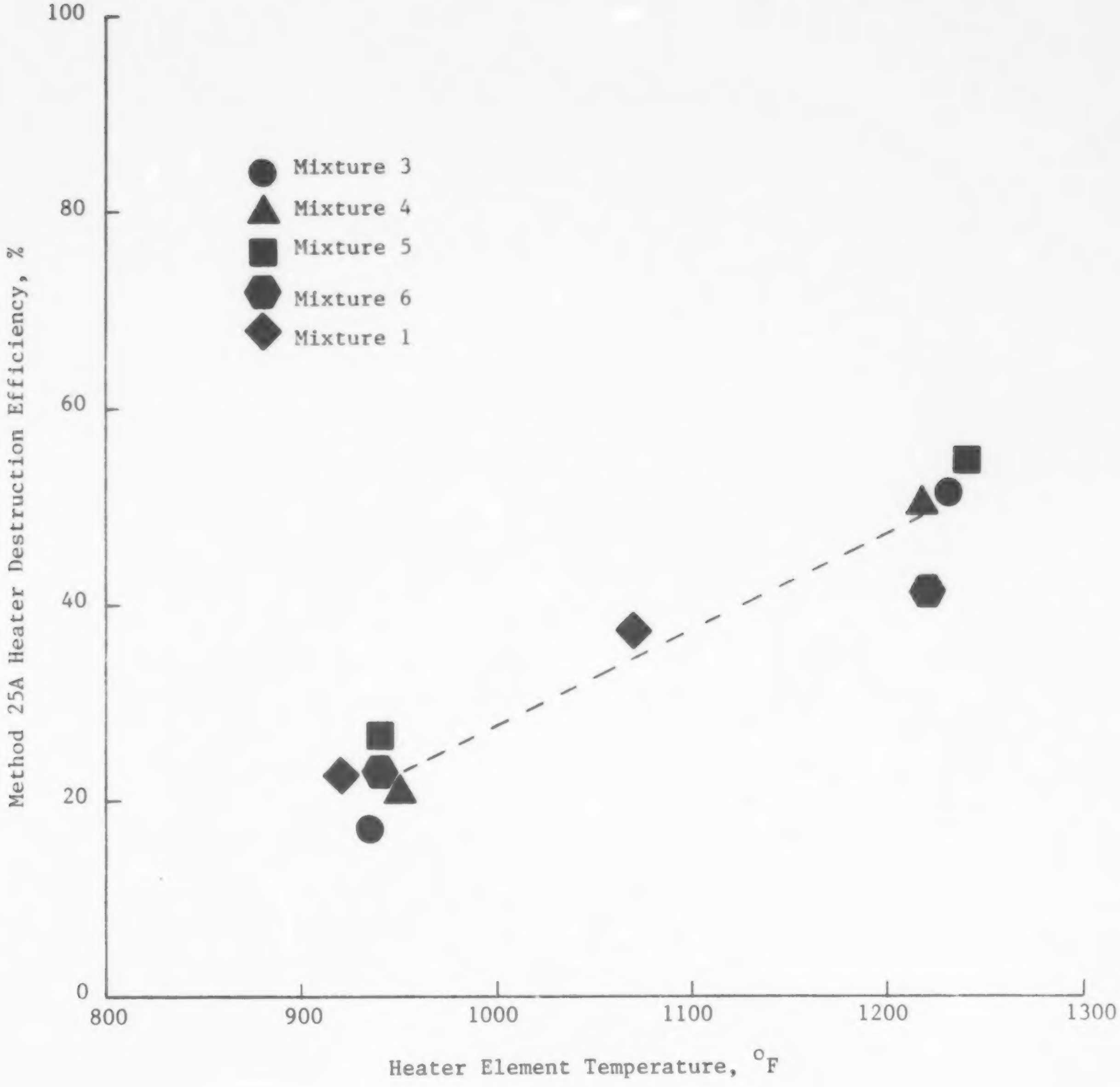

Figure 7-6. Heater destruction efficiency for small volume catalyst A at 50,000 hr^{-1}.

TABLE 7-11. HEATER DESTRUCTION EFFICIENCIES FOR LARGE VOLUME CATALYST A

Run Number	VOC Mixture	System Inlet Concentration[b] (ppmc)	Space Velocity (hr^{-1})	Catalyst Temperature Inlet °F	Catalyst Temperature Outlet °F	Heater Destruction Efficiency, %[c] Method 25A	Heater Destruction Efficiency, %[c] Method 18
E-1/E-1C	1	1374	50,000	597	631	9.9	16.9
E-3/E-3C	1	1233	30,000	600	627	22.1	21.6
E-2/E-2C	1	1311	30,000	698	717	30.0	25.9
E-4/E-4C	1	1336	30,000	798	812	41.3	45.3
E-5/E-5C	1	1253	20,000	600	617	29.4	32.2
E-6/E-6C	1	1271	20,000	699	706	44.1	48.5
E-11/E-11C	3	910	20,000	699	704	70.3	69.6
D-10/E-10C	3	1235	15,000	600	606	62.1	76.0
E-15/E-15C	4	1268	20,000	697	705	61.4	60.7
E-14/E-14C	4	1278	15,000	595	608	58.3	59.5
E-18/E-18C	6	1106	20,000	697	710	28.9	33.1
E-17/E-17C	6	1123	15,000	602	616	29.2	36.0

[a] Catalyst volume was 0.012 ft^3.

[b] Concentration at system inlet based on Method 18.

[c] Heater destruction efficiencies (DE) calculated from measured system and catalyst inlet concentrations for given operating conditions.

TABLE 7-12. CATALYST DESTRUCTION EFFICIENCIES FOR VARIOUS MIXTURES WITH SMALL VOLUME CATALYST A

Run Number	VOC Mixture	Space Velocity (hr^{-1})	Total Mixture Concentration[b] (ppmc)	Catalyst Inlet Temperature (°F)	Catalyst Outlet Temperature (°F)	Estimated Catalyst Destruction Efficiency (%)[c]	
						Method 25A	Method 18
C-49/C-49H	1	50,000	1,270	598	624	82.0	81.8
C-50/C-50H	1	50,000	1,265	698	724	86.1	86.5
C-46/C-46H	1	50,000	1,295	798	818	89.7	88.9
C-48/C-48H	1	30,000	1,250	595	620	89.7	90.0
C-43/C-43H	1	30,000	1,320	645	670	92.1	90.6
C-45/C-45H	1	20,000	1,265	698	722	93.5	91.0
C-42/C-47H	1	20,000	1,383	598	619	96.1	>94.1
C-44/C-44H	1	20,000	1,330	648	664	97.4	>93.3
C-51/C-51H	3	50,000	1,315	598	627	86.4	85.0
C-54/C-54H	3	50,000	1,433	790	816	92.7	91.4
C-52/C-52H	3	30,000	1,537	599	622	92.6	>93.7
C-53/C-53H	3	20,000	1,507	601	618	96.2	>91.9
C-63/C-63H	4	50,000	1,292	598	626	85.8	86.2
C-65/C-65H	4	50,000	1,531	790	817	90.0	>90.4
C-64/C-64H	4	20,000	1,321	598	618	95.3	>90.0
C-60/C-60H	5	50,000	884	597	626	90.6	89.0
C-62/C-62H	5	50,000	847	795	818	93.2	>91.9
C-61/C-61H	5	20,000	787	598	614	96.3	>88.5
C-55/C-55H	6	50,000	1,116	598	625	85.5	85.8
C-59/C-59H	6	50,000	1,060	790	818	88.5	88.0
C-56/C-56H	6	30,000	1,151	595	619	91.6	91.9
C-57/C-57H	6	20,000	1,110	598	618	96.8	94.9
C-66/C-66H	7	20,000	1,085	600	618	97.3	>96.1
C-73/C-73H	8	30,000	1,197	599	602	~0	~0
C-71/C-71H	8	30,000	1,296	698	706	17.6	10.4
C-70/C-70H	8	20,000	1,285	640	648	62.2	2.0

[a] Catalyst volume was 0.006 ft^3.

[b] Concentration at system inlet based on Method 18.

[c] Catalyst destruction efficiencies (DE) calculated from measured system and heater destruction efficienies for given operating conditions.

$$\text{Catalyst DE} = \frac{\text{System DE} - \text{Heater DE}}{100 - \text{Heater DE}}$$

heater destruction efficiencies measured at the conditions shown. In comparing the destruction efficiencies shown in Table 7-12 for different operating conditions, it should be noted that while system inlet concentrations were held fairly constant between test runs, catalyst inlet concentrations varied with heater destruction efficiency.

Based on the Method 25A data in Table 7-12, the highest catalyst destruction efficiencies for the various mixtures ranged from 62.2 percent for Mixture 8 to 97.4 percent for Mixture 1. Reasonable measurements of catalyst destruction could not be obtained with Method 18 at conditions with high heater destruction because of the low catalyst inlet concentrations and the 2.0 ppmC detection limit for each component.

Catalyst destruction efficiencies for the larger catalyst volume are shown in Table 7-13 for test Mixtures 1, 3, 4 and 6. The conditions tested with Mixtures 3, 4 and 6 were specifically selected to provide data on the temperatures and space velocities required to achieve 98 to 99 percent destruction across the catalyst. As shown in Table 7-13, these conditions were identified for all three mixtures.

Mixture 1 catalyst destruction efficiencies for the two catalyst A volumes are compared in Table 7-14. As shown in Table 7-14, destruction efficiencies for the larger catalyst volume are consistently higher than those for the smaller volume at all five test conditions for which comparable data are available. These higher catalyst destruction efficiencies ultimately resulted in higher system destruction.

The higher catalyst destruction efficiencies for the larger volume most likely result from the higher gas velocity through the catalyst bed for this volume. The difference in the destruction efficiency, based on a theoretical test for hetrogeneous catalytic reactions, indicates that the overall compound and oxygen reaction is diffusion limited at least for the smaller volume.[5] This means that the chemical reaction on the catalyst surface is

TABLE 7-13. CATALYST DESTRUCTION EFFICIENCIES FOR LARGE VOLUME CATALYST

Run Number	VOC Mixture	Catalyst Inlet Concentration[b] (ppmc)	Space Velocity[a] (hr^{-1})	Catalyst Temperatures Inlet °F	Catalyst Temperatures Outlet °F	Catalyst Destruction Efficiency, % (95% Confidence Interval) Method 25A	Catalyst Destruction Efficiency, % (95% Confidence Interval) Method 18
E-1C	1	1142	50,000	597	631	91.1 (90.2, 91.5)	93.1 (91.9, 94.3)
E-19C	1	991	50,000	797	818	96.3 (96.1, 96.5)	95.7 (95.4, 96.1)
E-3C	1	967	30,000	600	627	94.7, (94.4, 95.0)	94.7 (94.4, 94.9)
E-2C	1	838	30,000	698	717	96.8 (96.7, 97.0)	>96.8
E-4C	1	731	30,000	798	812	97.7 (97.5, 97.8)	>97.4
E-5C	1	849	20,000	600	617	96.6 (96.4, 96.7)	>96.8
E-6C	1	654	20,000	699	706	97.8 (97.7, 97.9)	>97.7
E-7C	1	786	15,000	597	611	98.2 (98.1, 98.3)	>97.9
E-9C	3	364	30,000	793	803	98.7 (98.6, 98.8)	>96.1
E-11C	3	336	20,000	699	803	98.8 (98.7, 98.9)	>95.8
E-10C	3	297	15,000	600	606	99.3 (99.2, 99.3)	>95.3
E-13C	4	432	30,000	798	804	97.5 (97.5, 97.6)	>96.8
E-15C	4	498	20,000	697	705	98.0 (97.9, 98.0)	>97.2
E-14C	4	518	15,000	595	608	98.0 (97.9, 98.1)	>97.3
E-16C	6	674	30,000	797	810	97.6 (97.5, 97.7)	>96.8
E-18C	6	740	20,000	697	710	98.3 (98.0, 98.6)	>96.5
E-17C	6	719	15,000	602	616	98.5 (98.4, 98.5)	>96.5

[a] Catalyst volume was 0.012 ft^3.

[b] Based on Method 18.

[c] NA = not available.

TABLE 7-14. EFFECT OF CATALYST VOLUME ON CATALYST DESTRUCTION EFFICIENCY

Run Number[a]	VOC Mixture	Catalyst Volume (ft3)	Space Velocity (hr^{-1})	Catalyst Inlet Concentration[b] (ppmc)	Inlet (°F)	Outlet (°F)	Catalyst Destruction Efficiency, %[c]	
							Method 25A	Method 18
C-49/C-49H	1	0.006	50,000	983	598	624	82.0	81.8
E-1C	1	0.012	50,000	1,142	597	631	91.1	93.1
C-46/C-46H	1	0.006	50,000	868	798	818	89.7	88.9
E-19C	1	0.012	50,000	991	797	818	96.3	95.7
C-48/C-48H	1	0.006	30,000	754	595	620	89.7	90.0
E-3C	1	0.012	30,000	967	600	627	94.7	94.7
C-45/C-45H	1	0.006	30,000	564	698	722	93.5	91.0
E-2C	1	0.012	30,000	838	698	717	96.8	>96.8
C-47/C-42	1	0.006	20,000	516	602	619	96.1	>94.1
E-5C	1	0.012	20,000	849	600	617	96.6	>96.8

[a] Based on Method 18.

[b] Catalyst destruction efficiencies (DE) for smaller catalyst volume calculated from system and heater destruction efficiencies measured at given operating conditions. Catalyst DE = $\frac{\text{System DE - Heater DE}}{\text{100 - Heater DE}}$

[c] Run numbers designated "C" and "H" represent measurement of catalyst and heater destruction efficiency only. Other runs represent system destruction.

occurring more quickly than the diffusion of the compound and oxygen from the bulk gas to the catalyst surface. The higher gas flowrate associated with the larger catalyst volume resulted in an increased gas velocity through the catalyst cells. This increase in gas velocity caused added turbulence and mixing in the gas, thus aiding diffusion and increasing the overall reaction rate.

The observed effect of gas velocity on catalyst destruction efficiency suggests a need for a minimum gas velocity through the catalyst to maximize destruction. Based on the tests conducted in this study, the minimum superficial gas velocity at the catalyst inlet is somewhere in excess of 13 to 16 ft/sec for catalyst A. Since no tests were conducted with a third catalyst A volume, better definition of the minimum velocity cannot be made on the basis of this study. Also, it should be noted that the minimum optimal superficial gas velocity will vary with catalyst geometry, for example with cell size in honeycomb catalysts or for metal ribbon catalyst compared to spherical pellets.

7.2.2 Effects on Component Destruction

The effects of catalyst inlet temperature and space velocity on component destruction efficiency for the various test mixtures are discussed in this section. This discussion is based primarily on a graphical presentation of system destruction efficiency data for the smaller volume of catalyst geometry A. However, selected portions of other system and catalyst efficiency data are presented for comparison. A complete listing of compound destruction efficiencies is presented in Appendix B, along with Method 18 and Method 25A mixture destruction efficiencies.

System destruction efficiencies for Mixture 1 components at a space velocity of 50,000 hr^{-1} are presented in Figure 7-7. As shown in Figure 7-7, n-hexane had a much lower destruction efficiency than the other four components at all catalyst inlet temperatures tested. Isopropanol, methyl ethyl ketone and ethyl acetate all showed similar trends of increasing

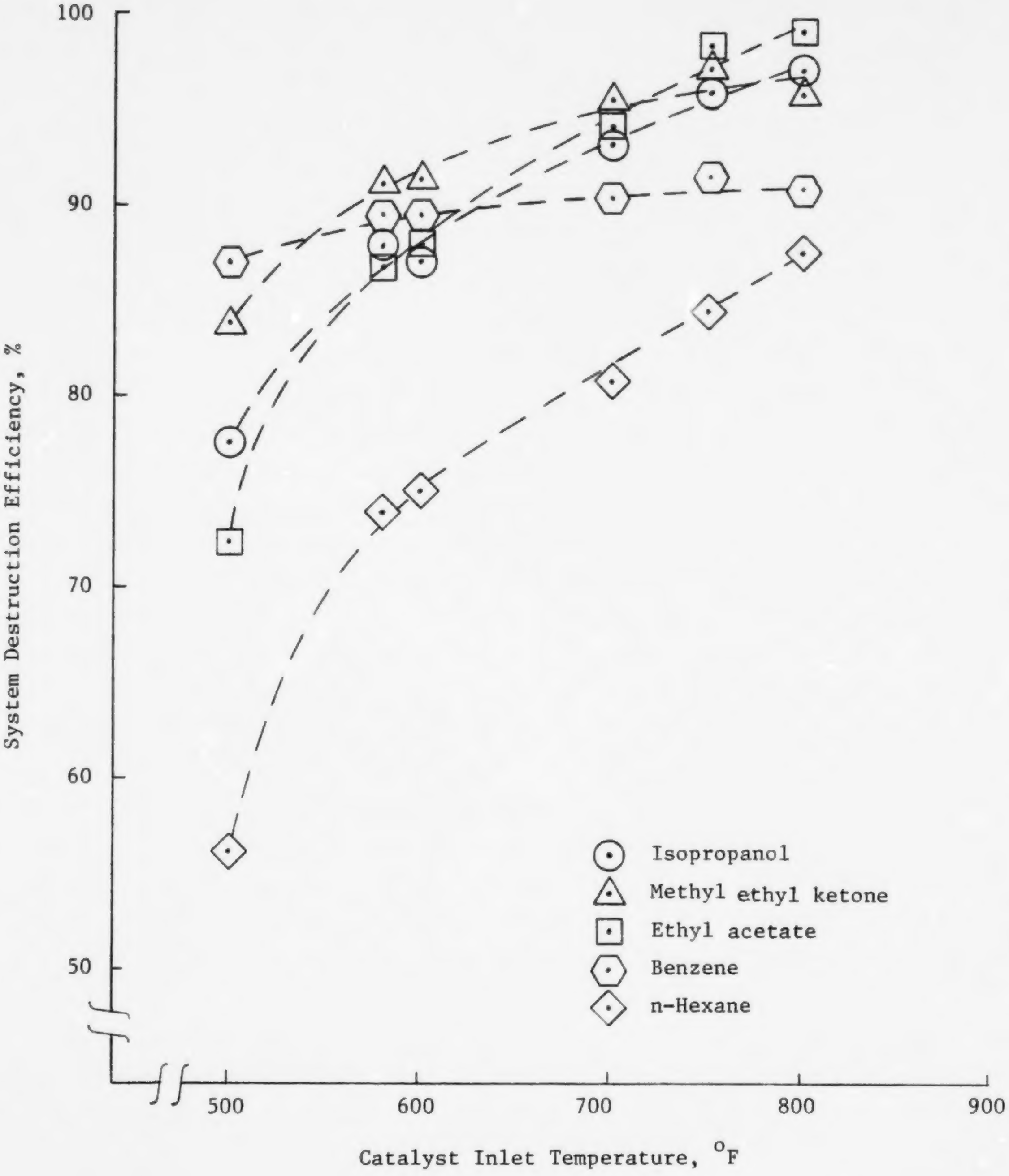

Figure 7-7. Component system destruction vs. temperature for Mixture 1 at 50,000 hr^{-1} with small volume catalyst A.

destruction with increasing temperature. The destruction efficiency of benzene was found to have a comparatively weak dependence on catalyst inlet temperature. Mixture 1 results for a space velocity of 30,000 hr^{-1} are shown for comparison in Figure 7-8. Although the destruction efficiencies of the five compounds are higher at the lower space velocity, similar trends in the component specific dependence on temperature were observed.

Destruction efficiencies for Mixture 3 components are shown as a function of catalyst inlet temperature at 50,000 hr^{-1} in Figure 7-9. The three acetate compounds, ethyl acetate, propyl acetate and isobutyl acetate, all show similar destruction efficiencies with a strong dependence on temperature. Three of the alcohols, methanol, ethanol and butanol, also show similar efficiencies, but with a weaker dependence on temperature. Isopropanol was found to have a significantly different dependence of destruction on temperature than the other alcohols and also showed a lower destruction efficiency in Mixture 3 than in Mixture 1 at this same space velocity (Figure 7-7 vs 7-9). Comparison of Mixture 3 results for two space velocities (Figures 7-9 and 7-10) again shows similar component specific trends with higher destruction at the lower space velocity.

The Mixture 4 results presented in Figures 7-11 and 7-12 also show similar destruction efficiencies for some compounds in the same chemical class. Of the ketone compounds, acetone, methyl ethyl ketone and methyl isobutyl ketone show similar destruction efficiencies, while efficiencies for cyclohexanone are considerably higher at the lower temperatures. Of the seven Mixture 4 components, dioxane had the lowest destruction efficiency.

Four of the five aldehyde compounds in Mixture 5 were found to have similar destruction efficiencies as illustrated in Figures 7-13 and 7-14. Destruction efficiencies for propionaldehyde were slightly lower than for the other four compounds.

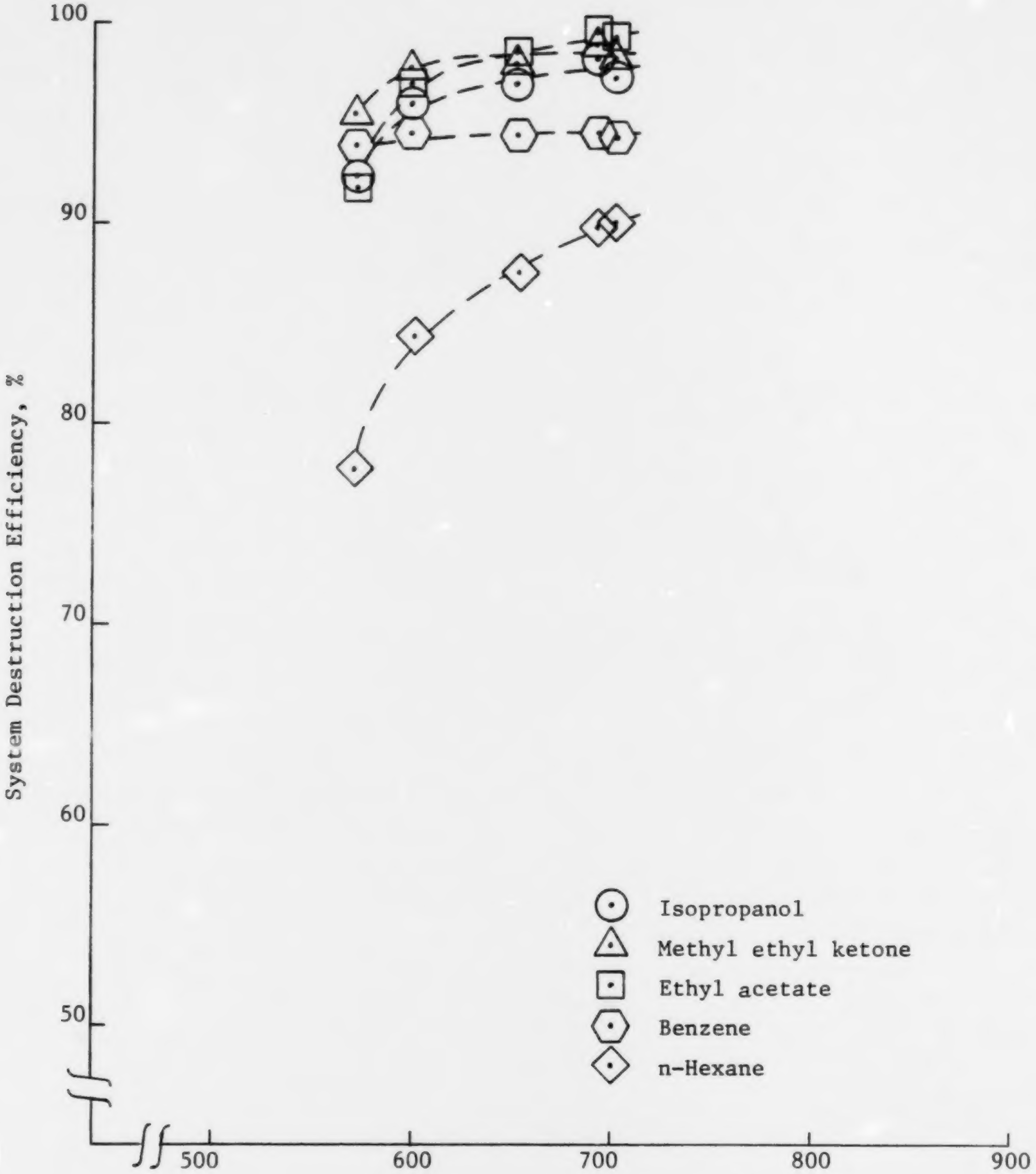

Figure 7-8. Component system destruction vs. temperature for Mixture 1 at 30,000 hr^{-1} with small volume catalyst A.

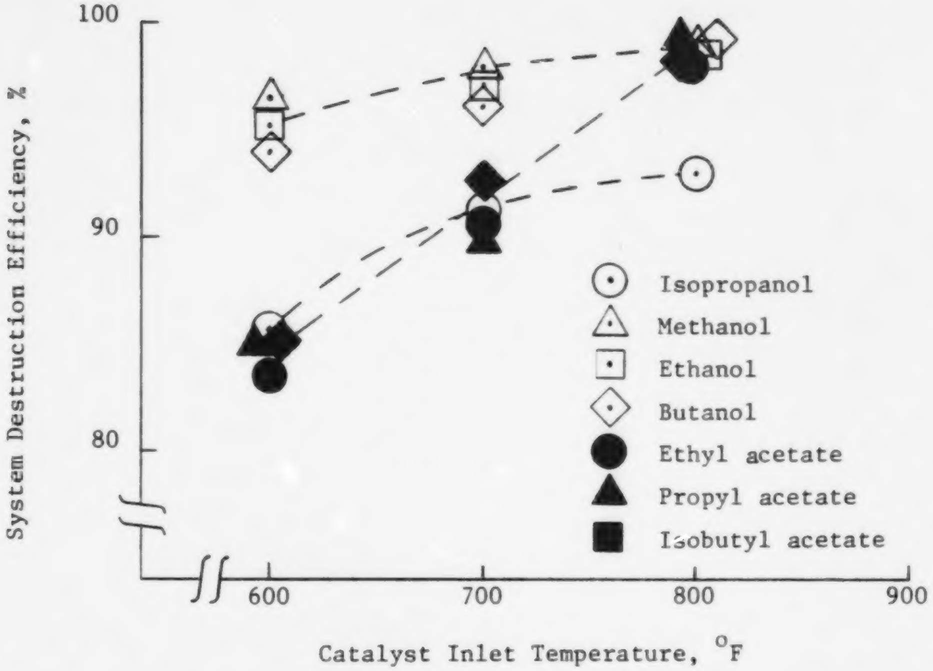

Figure 7-9. Component system destruction vs. temperature for Mixture 3 at 50,000 hr^{-1} with small volume catalyst A.

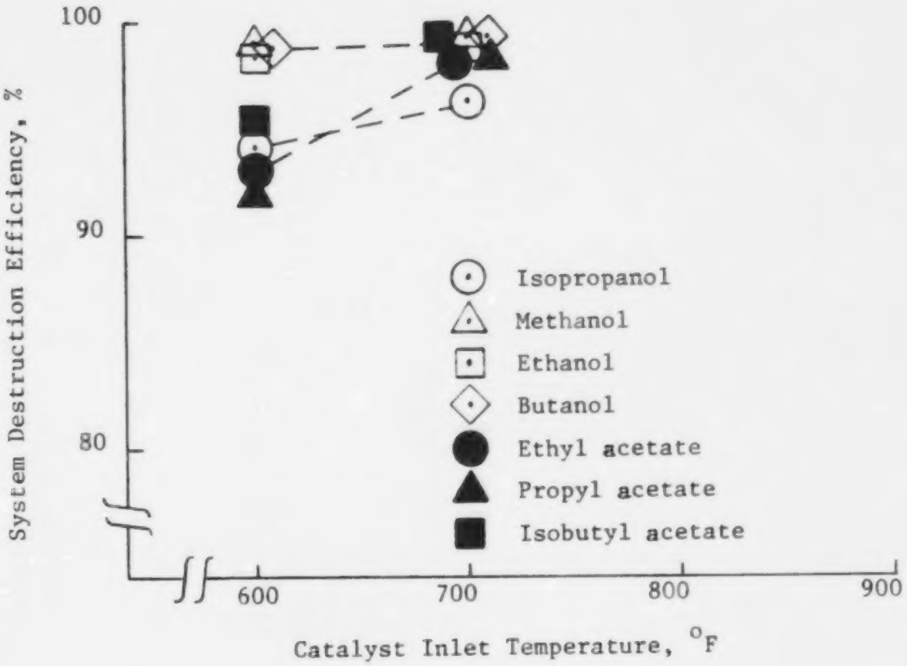

Figure 7-10. Component system destruction vs. temperature for Mixture 3 at 30,000 hr^{-1} with small volume catalyst A.

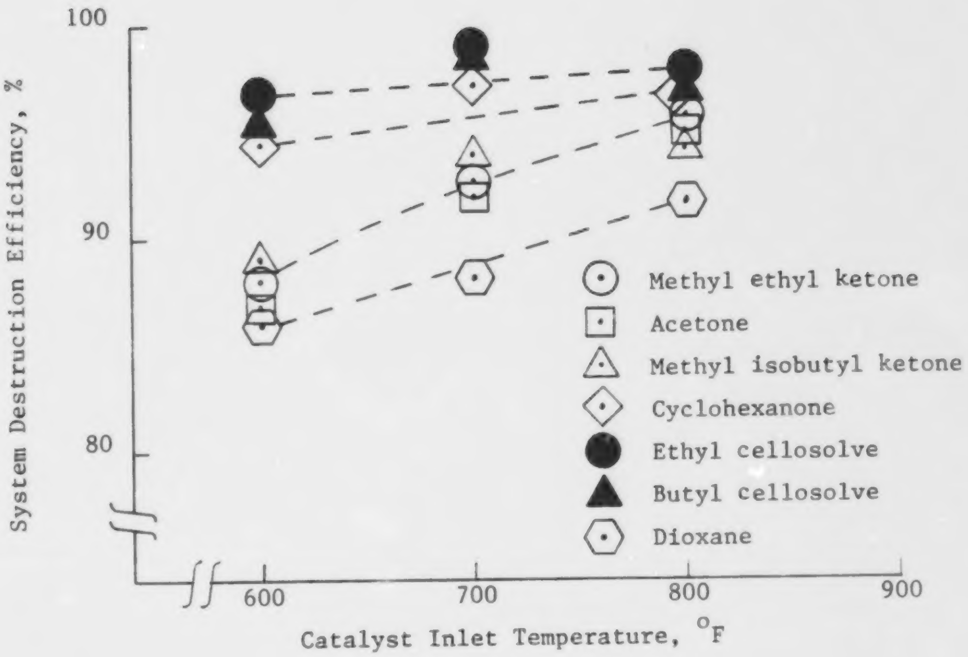

Figure 7-11. Component system destruction vs. temperature for Mixture 4 at 50,000 hr^{-1} with small volume catalyst A.

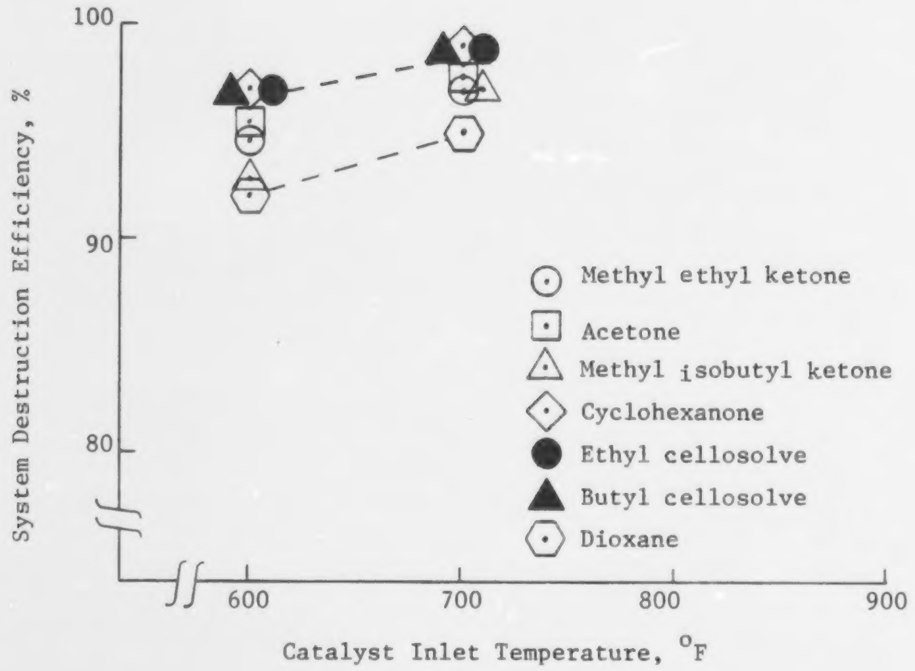

Figure 7-12. Component system destruction vs. temperature for Mixture 4 at 30,000 hr^{-1} with small volume catalyst A.

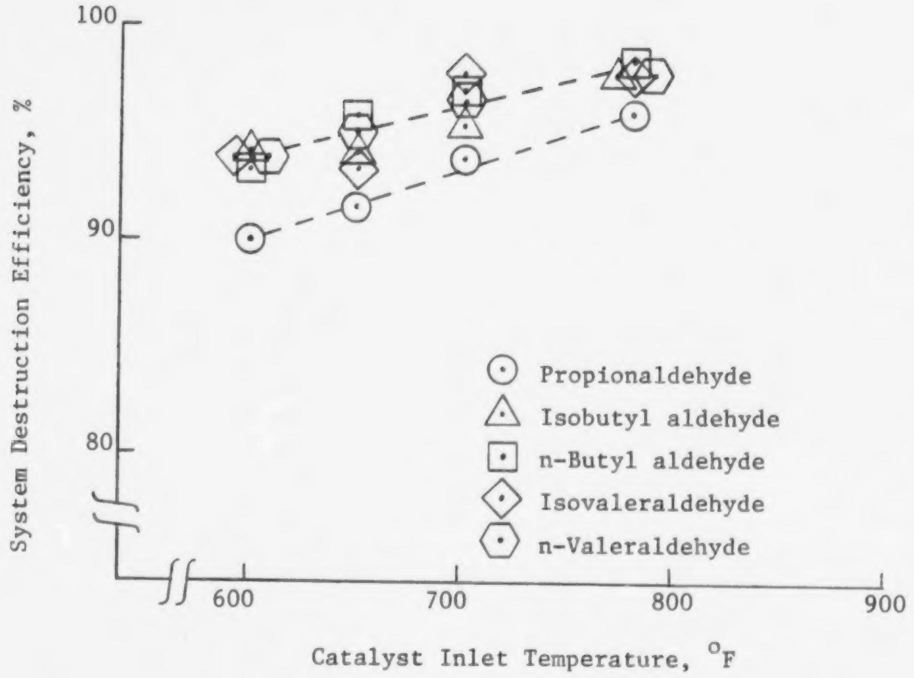

Figure 7-13. Component system destruction vs. temperature for Mixture 5 at 50,000 hr^{-1} with small volume catalyst A.

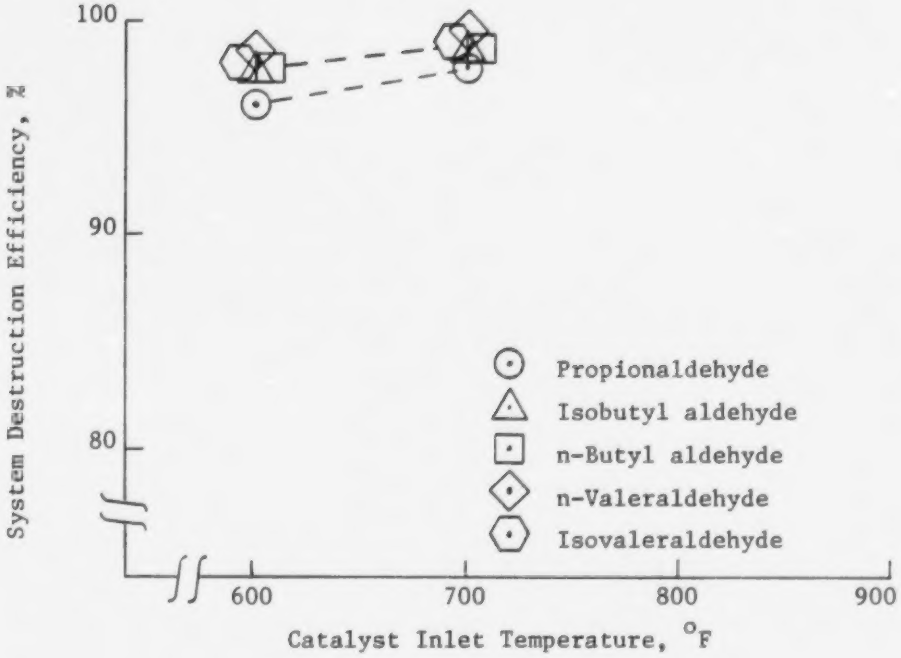

Figure 7-14. Component system destruction vs. temperature for Mixture 5 at 30,000 hr^{-1} with small volume catalyst A.

Interpretation of the Mixture 6 results presented in Figures 7-15 and 7-16 is difficult because the data show a considerable amount of scatter, particularly for n-hexane and benzene. However, several trends are observed. First, at least three of the aromatic compounds, toluene, xylene and isopropyl benzene, show similar destruction efficiencies and trends with temperature. Second, n-octane and n-decane also show similar efficiencies. A final observation is that, unlike other compound groups tested, the linear alkanes show consistantly higher destruction efficiencies with increasing molecular weight.

Based on four test runs conducted with Mixture 7, m-cresol showed system destruction efficiencies of at least 2 percent greater than those for acrylonitrile. The higher destruction for m-cresol may be attributed somewhat to the significantly higher heater destruction observed for m-cresol compared to acrylonitrile. For example, at a space velocity of 30,000 hr^{-1} and an inlet temperature of 650°F, heater destruction efficiencies measured for m-cresol and acrylonitrile were 85.7 percent and approximately zero percent respectively.

As discussed in Section 7.2.1, destruction efficiencies for the chlorinated hydrocarbon mixture (Mixture 8) showed much lower destruction efficiencies than the other test mixtures. The majority, and in some cases all, of the observed destruction for Mixture 8 occured in the heater. Three of the seven compounds, in Mixture 8, including tetrachloroethylene, methylene chloride and trichloroethylene showed catalyst destruction efficiencies of 3 percent or less at all conditions tested. The highest observed catalyst destruction efficiencies for the other compounds ranged from 17 percent for 1,2 dichloroethane to 50 percent for carbon tetrachloride.

Catalyst destruction efficiencies for Mixture 1 components with the larger and smaller catalyst A volumes at 50,000 hr^{-1} are shown in Figures 7-17 and 7-18 respectively. Comparison of the two figures shows that

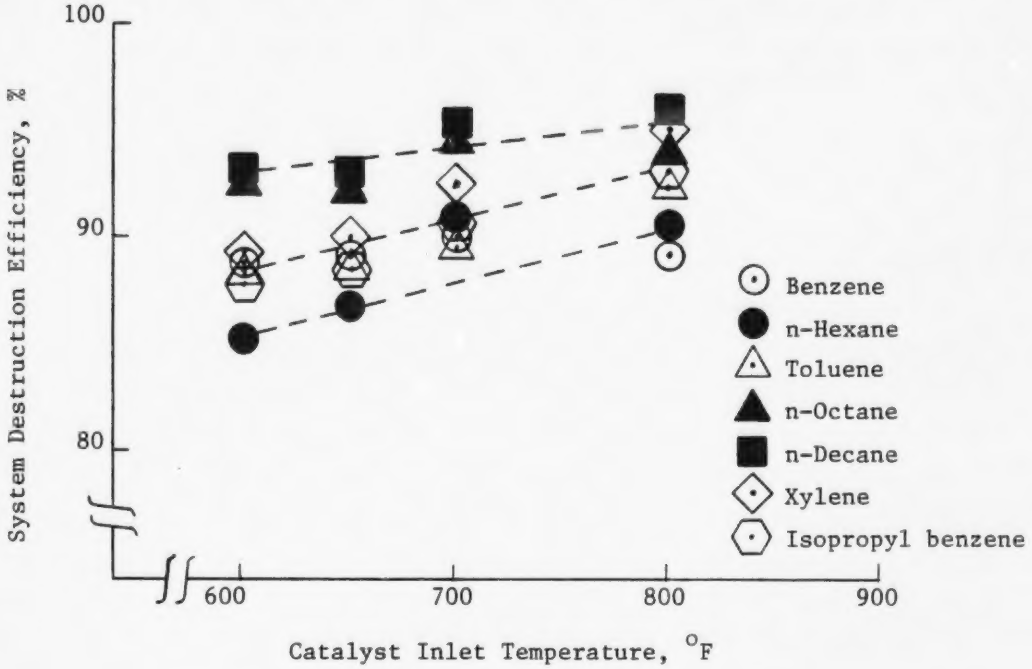

Figure 7-15. Component system destruction vs. inlet temperature for Mixture 6 at 50,000 hr^{-1} with small volume catalyst A.

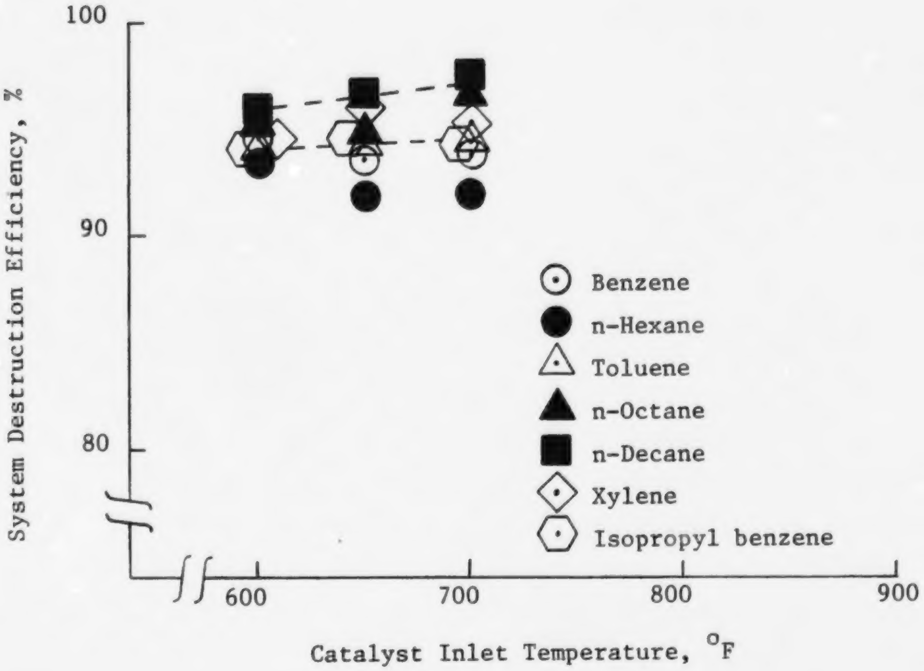

Figure 7-16. Component system destruction vs. inlet temperature for Mixture 6 at 30,000 hr^{-1} with small volume catalyst A.

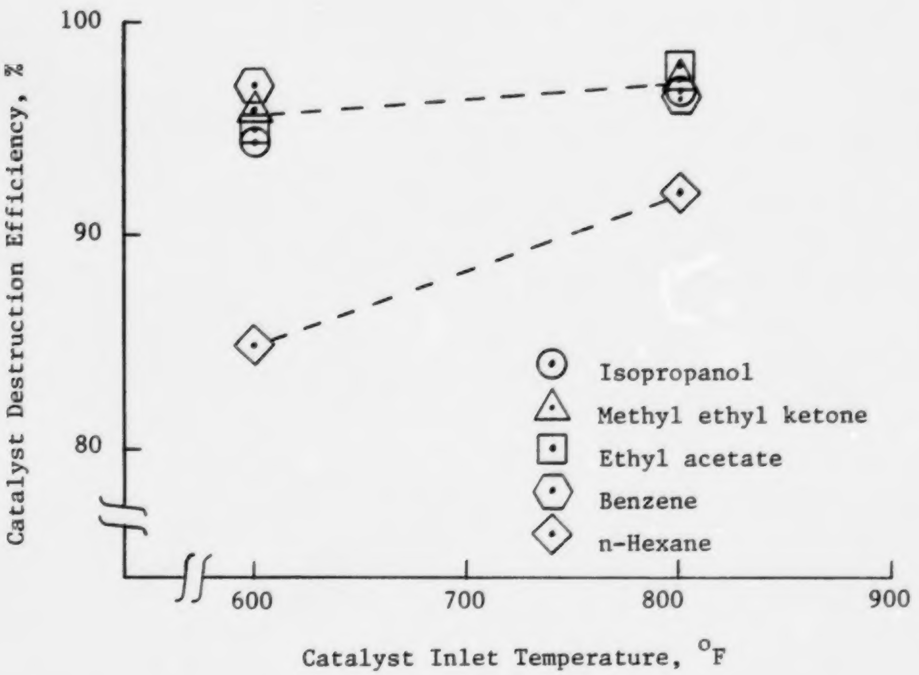

Figure 7-17. Component catalyst destruction vs. inlet temperature for Mixture 1 at 50,000 hr^{-1} with large volume catalyst A.

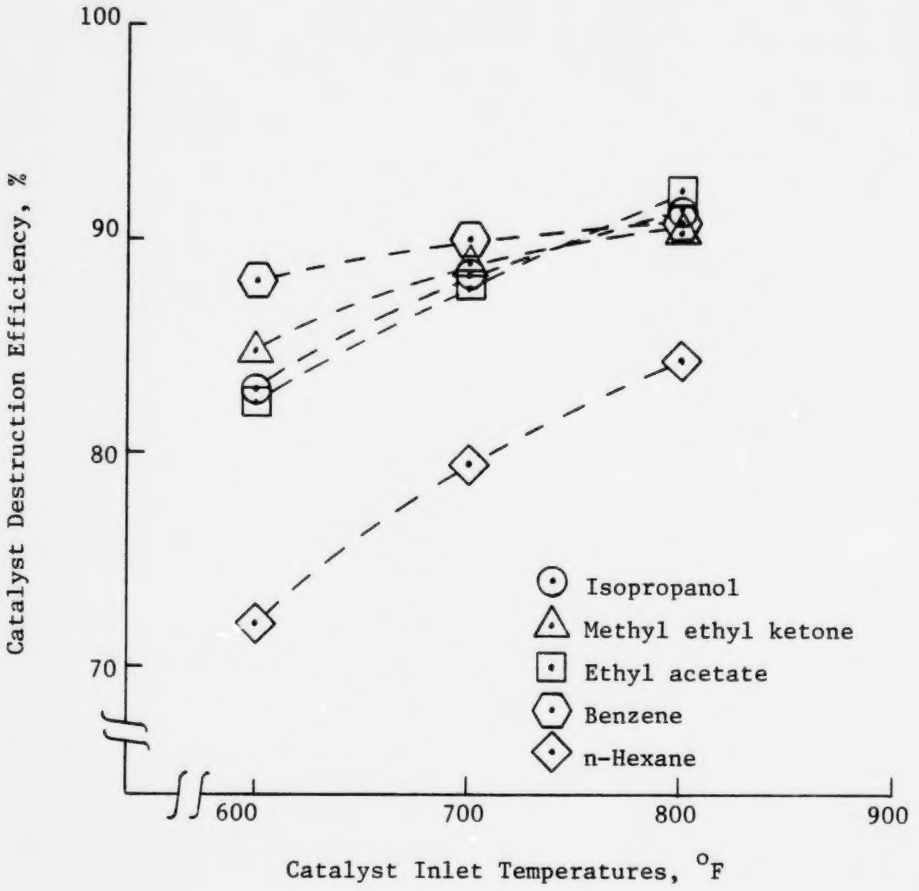

Figure 7-18. Component catalyst destruction vs. inlet tempe[illegible]ure for Mixture 1 at 50,000 hr^{-1} with small volume catalyst A.

(1) destruction efficiencies for the larger catalyst volume are higher for all compounds and (2) differences between the destruction efficiencies of isopropanol, methyl ethyl ketone, ethyl acetate and benzene are much greater for the smaller catalyst volume. A meaningful comparison of Mixture 1 data for the two catalyst volumes at space velocities of 30,000 and 20,000 hr^{-1} cannot be made because of the 2.0 ppmC detection limit for each component. At the high destruction efficiencies occuring for the larger catalyst volume at 30,000 and 20,000 hr^{-1}, measurable outlet concentrations were not observed for any components except hexane. Similarly catalyst destruction efficiencies for components in Mixtures 3, 4 and 6 with the two catalyst volumes cannot be meaningfully compared. As discussed in Section 7.2.1, conditions for these tests were selected to provide mixture catalyst destruction efficiencies in the 98 to 99 percent range. Under these conditions, incinerator outlet concentrations of all components in Mixtures 3, 4 and 6 were below the 2.0 ppm detection limit for Method 18.

7.3 RELATIVE COMPOUND DESTRUCTION

Objectives of this study included the collection of data on a large number of compounds to allow (1) an assessment of the capability of catalytic incineration to achieve high destruction efficiencies (near 98 percent) on a wide variety of compounds and (2) an estimate of the relative destruction of the various compound classes. Based on the data presented in Section 7.2., catalyst destruction efficiencies of 98 percent or higher should be achievable for all 28 compounds in Mixtures 3 through 7 at sufficiently low space velocities and/or high enough catalyst inlet temperatures. The only class of compounds showing poor catalyst destructability was the chlorinated hydrocarbons.

The relative destructability of selected compounds and compound groups is presented in Table 7-15. The compound or compound groups are listed in order of increasing ease of destructability based on catalyst destruction efficiencies at three test conditions. Destruction efficiencies shown in

TABLE 7-15. RELATIVE DESTRUCTABILITY OF SELECTED COMPOUNDS AND COMPOUND GROUPS

	Catalyst Destruction Efficiency, %[a]		
	$50,000\ hr^{-1}$	$30,000\ hr^{-1}$	$50,000\ hr^{-1}$
Catalyst Inlet Temperature	600°F	600°F	800°F
Compound or Compound Group			
Chlorinated hydrocarbons	NA[b]	~0	20.1[c]
Alkanes[d]	77.1	88.5	82.7
Ethyl/Propyl/Isobutyl Acetates	78.9	92.5	86.4
Isopropanol	82.7	93.7	91.9
Methyl Ethyl Ketone/ Acetone/Methyl Isobutyl Ketone	84.3	NA	90.8
Aromatics[e]	86.2	NA	90.6
Dioxane	86.6	NA	89.8
Cyclohexane	87.5	NA	>89.4
Other Aldehydes[f]	89.0	NA	>90.6
Propionaldehyde	89.4	NA	94.5
Ethyl Cellosolve/Butyl Cellosolve	90.2	93.3	>90.3
Methanol/Ethanol Butanol	93.5	>95.9	>94.2

[a] Based on Method 18 results for components of Mixtures 3 through 6 with catalyst geometry A.

[b] NA = not available.

[c] System destruction efficiency. Catalyst destruction not available.

[d] Includes n-hexane, n-decane and n-octane in Mixture 6.

[e] Includes benzene, toluene, xylene, isopropylbenzene in Mixture 6.

[f] Includes iso-butyl aldehyde, n-butyl aldehyde, n-valeraldehyde and iso-valeraldehyde in Mixture 5.

Table 7-15 are based solely on test results for Mixtures 3 through 6, with the smaller volume of catalyst A. Comparable heater and catalyst data for Mixture 7 are not available. The compound groups in Table 7-15 were selected on the basis of the observed similarities in component destruction efficiency and temperature dependence discussed in Section 7.2.2.

As shown in Table 7-15 and as indicated by the discussions of mixture effects in Section 7.1, alkanes appear to be the most difficult compounds to destroy with catalyst A (with the exception of chlorinated hydrocarbons). Acetates also appear to be somewhat harder to destroy than the other compounds listed in Table 7-15.

Differences in the destructability of the remaining compounds is difficult to assess on the basis of the data in Table 7-15. However, the alcohol compounds appear to be the most easily destroyed of the groups listed.

7.4 EFFECT OF CHLORINATED HYDROCARBONS

Following tests with the chlorinated hydrocarbons group (Mixture 8), additional testing with Mixture 1 was conducted to assess potential effects of the chlorinated compounds on catalyst activity. Mixture 1 system destruction efficiencies measured before and after the Mixture 8 tests are compared in Table 7-16. The data in Table 7-16 show that operation with the chlorinated hydrocarbons resulted in partial deactivation of the catalyst. No tests were conducted to see if the deactivation was permanent or reversible. Mixture 1 system destruction efficiencies were found to be reduced by approximately 15 percent at an inlet temperature of 600°F and 3 percent at 800°F.

7.5 EFFECTS OF CATALYST GEOMETRY

The results of tests conducted with catalyst geometries A and B are compared in this section. Both catalysts were tested with volumes of

TABLE 7-16. EFFECT OF CHLORINATED COMPOUNDS ON CATALYST A PERFORMANCE

Run Number	Test Condition (Test Date)[a]	Space Velocity (hr^{-1})	System Inlet Concentration[b] (ppmc)	Catalyst Temperatures		System Destruction Efficiency, % (95% Confidence interval)	
				Inlet (°F)	Outlet (°F)	Method 25A	Method 18
C-49	Before chlorinated compounds (3/21/84)	50,000	1,273	598	624	86.1 (85.1, 87.2)	86.1 (85.7, 86.5)
C-79	After chlorinated compounds (3/30/84)	50,000	1,326	597	617	71.7 (70.3, 71.9)	76.0 (75.5, 76.5)
C-46	Before chlorinated compounds (3/20/84)	50,000	1,295	798	818	92.8 (90.9, 94.2)	94.1 (93.8, 94.5)
C-80	After chlorinated compounds (3/30/84)	50,000	1,365	798	818	89.5 (88.3, 90.7)	91.4 (90.4, 92.3)

[a] Testing with chlorinated compounds was conducted between 3/28/84 and 3/30/84.

[b] Total concentration at system inlet based on Method 18.

0.006 ft^3 and with Mixtures 1 and 6. System destruction efficiencies for the two catalysts are compared in Table 7-17. The data show consistantly higher system destruction efficiencies for catalyst B. Catalyst destruction efficiencies are compared for the two catalysts in Table 7-18. On the average, catalyst destruction efficiencies for catalyst B were found to be approximately 4 percent higher at a space velocity of 50,000 hr^{-1}. The major difference between the two catalyst geometries is the total catalyst surface area per unit volume of catalyst. For catalyst A the surface area was 270 ft^2/ft^3 and for catalyst B the area was 660 ft^2/ft^3. In addition to system and catalyst destruction efficiencies, the two catalysts also showed differences in catalyst bed pressure drop. Catalyst B, which had the smaller cell diameter, had a pressure drop of 15 in. H_2O at 5 scfm compared to 1.0 in. H_2O for catalyst A.

7.6 CONCENTRATION EFFECTS

The effect of system inlet concentration on Mixture 1 component destruction efficiencies is shown in Tables 7-19 and 7-20 for catalyst inlet temperatures of 580 and 750°F, respectively. Data presented in Tables 7-19 and 7-20 include both pure compound (single) and mixture component (multi) destruction efficiencies, all measured at a space velocity of 50,000 hr^{-1} with 0.006 ft^3 of catalyst geometry A. Mean destruction efficiencies were adjusted for variations in inlet concentration around the desired test conditions of 250, 1,200 or 6,000 ppmC, and for the larger catalyst bed temperature rise occurring at the higher inlet concentrations.

Results at the lower temperature (Table 7-19) show statistically significant increases in component destruction with increasing concentration in all but two cases. For n-hexane and n-octane as pure components, the effect of concentration on destruction was not found to be statistically significant, although the mean destruction efficiencies of both compounds did show a slight increase at the higher concentration.

TABLE 7-17. EFFECT OF CATALYST GEOMETRY ON SYSTEM DESTRUCTION EFFICIENCY

Run Number	VOC Mixture	Space Inlet Concentration[b] (ppmc)	Space Velocity (hr^{-1})	Catalyst Temperature		Catalyst Geometry	System Destruction Efficiency (95 % Confidence Interval)	
				Inlet °F	Outlet °F		Method 25A	Method 18
C-41	1	1305	50,000	598	626	A	87.7 (86.5, 88.7)	86.2 (85.9, 86.5)
D-4	1	1248	50,000	598	625	B	87.8 (87.2, 88.5)	90.4 (90.3, 90.5)
C-55	6	1116	50,000	598	625	A	88.9 (88.2, 89.4)	90.7 (90.1, 91.2)
D-7	6	1112	50,000	599	625	B	96.9 (96.7, 97.0)	94.4 (94.3, 94.5)
C-50	1	1262	50,000	698	724	A	91.2 (90.7, 91.6)	90.8 (90.6, 91.0)
D-5	1	1249	50,000	697	720	B	93.9 (93.7, 94.2)	94.4 (94.8, 94.9)
C-58	6	1044	50,000	697	721	A	90.6 (90.3, 90.9)	91.2 (90.9, 91.6)
D-9	6	1138	50,000	695	718	B	95.4 (95.2, 95.5)	95.7 (95.6, 95.8)
C-46	1	1295	50,000	798	818	A	92.8 (90.9, 94.2)	94.1 (93.8, 94.5)
D-3	1	1214	50,000	797	812	B	96.1 (95.7, 96.3)	96.2 (96.1, 96.3)
C-48	1	1248	30,000	595	620	A	93.9 (93.7, 94.2)	94.0 (93.7, 94.2)
D-1	1	1289	30,000	598	619	B	92.9 (91.8, 93.7)	92.9 (92.3, 93.4)
C-56	6	1151	30,000	595	618	A	94.2 (94.0, 94.3)	94.8 (94.7, 95.0)
D-6	6	1119	30,000	599	621	B	96.9 (96.7, 97.0)	97.0 (96.9, 97.1)
C-45	1	1263	30,000	698	722	A	96.1 (95.9, 96.3)	96.0 (95.8, 96.1)
D-2	1	1287	30,000	697	715	B	97.7 (97.4, 97.9)	98.1 (98.0, 98.2)
C-33	6	1152	30,000	698	724	A	95.8 (95.6, 95.9)	95.0 (94.4, 95.7)
D-8	6	1177	30,000	695	715	B	98.0 (97.9, 98.0)	98.4 (98.2, 98.5)

[a] Total concentration at system inlet based on Method 18.

[b] The two catalysts had the same volume (0.006 ft^3) and formulation, but different cell diameters and surface areas. Catalysts A had a 0.109 in. cell diameter with 270 ft^2/ft^3 surface area. Catalyst B had a 0.046 in. cell diameter with 660 ft^2/ft^3 surface area.

TABLE 7-18. EFFECT OF CATALYST GEOMETRY ON MIXTURE 1 CATALYST DESTRUCTION EFFICIENCY

Run Number	VOC Mixture	System Inlet Concentration[a] (ppmc)	Space Velocity (hr^{-1})	Catalyst Temperatures Inlet °F	Catalyst Temperatures Outlet °F	Catalyst Geometry	Catalyst Destruction Efficiency, %[c] Method 25A	Catalyst Destruction Efficiency, %[c] Method 18
C-49/C-49H	1	1270	50,000	598	624	A	82.0	81.8
D-4/D-4H	1					B	86.1	86.1
C-50/C-50H	1	1265	50,000	698	724	A	86.1	86.5
D-5/D-5H	1					B	90.9	91.5
C-46/C-46H	1	1295	50,000	798	818	A	89.7	88.9
D-3/D-3H	1					B	91.7	93.2
C-55/C-55H	6	1116	50,000	598	625	A	85.5	85.8
D-7/D-7H	6					B	91.6	91.7

[a] Total concentration at system inlet based on Method 18.

[b] The two catalyst had the same volume (0.006 ft^3) and formulation, but different cell diameters and surface areas. Catalyst A had a 0.109 in. cell diameter with 270 ft^2/ft^3 surface area. Catalyst B had a 0.046 in. cell diameter with 660 ft^2/ft^3 surface area.

[c] Catalyst destruction efficiencies (DE) calculated from measured system and heater destruction efficiencies at given operating conditions.

$$\text{Catalyst DE} = \frac{\text{System DE} - \text{Heater DE}}{100 - \text{Heater DE}}$$

TABLE 7-19. EFFECT OF SYSTEM INLET CONCENTRATION AT LOW TEMPERATURE

Component	Type of Mixture	Component Inlet Concentration[a] (ppmc)	Catalyst Inlet Temperature[b] (°F)	System Destruction Efficiency, %		Statistically Significant Difference ?
				Mean	Adjusted Mean[c]	
iso-Propanol	Multi	250	580	87.4	86.7	Yes[d]
		1200		90.3	90.9	
Methyl ethyl ketone	Multi	250	580	90.3	88.4	Yes
		1200		91.2	92.2	
Ethyl acetate	Multi	250	580	86.9	86.3	Yes
		1200		88.6	88.9	
Benzene	Multi	250	580	89.5	89.3	Yes
		1200		91.2	91.3	
n-Hexane	Multi	250	580	73.7	73.8	Yes
		1200		81.7	82.0	
Total hydrocarbons (Mixture 1)	Multi	1200	580	85.5	85.0	Yes
		6000		88.6	88.9	
Ethyl acetate	Single	1200	580	78.4	77.9	Yes
		6000		82.4	82.8	
n-Hexane	Single	1200	580	91.0	91.1	Yes
		6000		94.2	93.5	
n-Octane	Single	1200	580	96.9	ND[f]	No[e]
		6000		97.4		
iso-Octane	Single	1200	580	75.4	ND	Yes
		6000		80.0		

[a] Concentration at system inlet based on Method 18.

[b] Nominal or desired temperature. Actual values of test runs included in the statistical analysis may have varied by ±5°F from desired temperature.

[c] Mean destruction efficiencies adjusted for concomitant variables of catalyst inlet concentration and temperature rise.

[d] "Yes" indicates a 95 percent probability that the observed difference in destruction is due to a concentration effect.

[e] "No" indicates that no conclusion can be drawn regarding the presence or absence of a concentration effect.

[f] ND = not determined due to insufficient data.

TABLE 7-20. EFFECT OF SYSTEM INLET CONCENTRATION AT HIGH TEMPERATURE

Component	Type of Mixture	Component Inlet Concentration[a] (ppmc)	Catalyst Inlet Temperature[b] (°F)	System Destruction Efficiency, %		Statistically Significant Difference ?
				Mean	Adjusted Mean[c]	
iso-Propanol	Multi	250	750	96.0	95.0	No[d]
		1200		95.8	95.9	
Methyl ethyl ketone	Multi	250	750	97.0	94.6	Yes[e]
		1200		96.3	96.5	
Ethyl acetate	Multi	250	750	98.1	97.4	No
		1200		97.6	97.6	
Benzene	Multi	250	750	91.7	91.4	No
		1200		92.3	92.1	
n-Hexane	Multi	250	750	84.3	84.5	Yes
		1200		87.1	87.0	
Total hydrocarbons	Multi	1200	750	93.4	92.7	No
(Mixture 1)		6000		93.8	93.6	
n-Hexane	Single	1200	750	93.7	93.6	No
		6000		95.5	94.6	
iso-Octane	Single	1200	750	80.2	ND[f]	Yes
		6000		83.0		
Cyclohexane	Single	1200	750	86.0	ND	Yes
		6000		88.4		

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[a] Concentration at system inlet based on Method 18.

[b] Nominal or desired temperature. Actual values of test runs included in the statistical analysis may have varied by ±5°F from desired temperature.

[c] Mean destruction efficiencies adjusted for concomittant variables of catalyst inlet concentration and temperature rise.

[d] "No" indicates that no conclusion can be drawn regarding the presence or absence of a concentration effect.

[e] "Yes" indicates a 95 percent probability that the observed difference in destruction is due to a concentration effect.

[f] ND = not determined due to insufficient data.

The higher temperature data (Table 7-20) show a much smaller effect of inlet concentration on destruction efficiency. Adjusted mean destruction efficiencies are slightly higher for all cases except ethyl acetate. However, the observed increases in destruction are statistically significant in only four of the nine cases shown in Table 7-20.

Based on the data in Tables 7-19 and 7-20, higher destruction efficiencies can be expected at higher inlet concentrations, with the greatest effect occurring at lower catalyst inlet temperatures. In addition, the dependence of destruction efficiency on inlet concentration suggests that for this volume of catalyst geometry A, the overall reaction rate between the Mixture 1 solvents and oxygen in the catalyst bed is limited by the diffusion of solvent and oxygen from the bulk gas to the catalyst surface. This finding is in agreement with the observed effect of superficial catalyst inlet velocity discussed in Section 7.2.1.

7.7 LOW OXYGEN, ETHYLENE OXIDE OFF-GAS

The results of tests conducted with the simulated ethylene oxide process off-gases are shown in Tables 7-21 and 7-22 for 0.012 ft^3 of catalyst geometries B and A respectively. Measured inlet concentrations of ethylene, ethylene oxide and ethane are shown along with measured oxygen values and the calculated stochiometric oxygen requirement. Volatile organic compound (VOC) destruction efficiencies are based on the destruction of ethylene and ethylene oxide only. Total hydrocarbon (THC) destruction efficiencies also include ethane. Run numbers with a "C" designation indicate destruction across the catalyst only.

As shown in Tables 7-21 and 7-22, VOC destruction efficiencies for the simulated off-gas exceeded 99 percent at all conditions tested with both catalyst geometries. THC destruction efficiencies ranged from approximately 95 to greater than 99 percent. Slightly lower destruction efficiencies were observed for catalyst A compared to catalyst B. THC heater destruction

TABLE 7-21. ETHYLENE OXIDE OFF-GAS RESULTS FOR CATALYST B

Run Number[a]	Space Velocity (hr^{-1})	Catalyst Temperatures Inlet °F	Catalyst Temperatures Outlet °F	Inlet Concentration (ppmc)[b] Ethylene	Inlet Concentration (ppmc)[b] Ethylene Oxide	Inlet Concentration (ppmc)[b] Ethane	Measured Inlet Oxygen (% by Volume)	Stoichiometric Oxygen (% by Volume)[c]	VOC Destruction Efficiency, %[d]	Total NMHC[e] Destruction Efficiency, % Method 18	Total NMHC[e] Destruction Efficiency, % Method 25A
F-1	47,000	504	845	8109	214	1642	1.58	1.53	>99.9	>98.3	97.8
F-4	50,000	506	821	7918	56	1541	1.61	1.46	>99.9	>98.2	96.9
F-3	30,000	598	893	7973	104	1434	1.77	1.46	>99.9	>99.9	99.8
F-1C	47,000	504	845	8083	206	1634	1.60	1.52	>99.9	>98.2	97.7
F-2C	30,000	609	942	8253	205	1691	1.63	1.56	J99.9	>99.8	99.7
F-3C	30,000	598	893	7715	69.0	1375	1.75	1.41	>99.9	>99.9	99.9

[a] Run numbers with "C" designation represent measurement of catalyst destruction efficiencies. Other runs represent system destruction.

[b] Concentrations at system or catalyst inlet based on Method 18.

[c] Based on measured inlet concentrations and combustion calculations.

[d] Volatile organic compound (VOC) destruction efficiencies based on ethylene and ethylene oxide only.

[e] NMHC = non-methane hydrocarbons.

TABLE 7-22. ETHYLENE OXIDE OFF-GAS RESULTS FOR CATALYST A

Run Number[a]	Space Velocity (hr^{-1})	Catalyst Temperatures		Inlet Concentration (ppmc)[b]			Measured Inlet Oxygen (% by Volume)	Stoichiometric Oxygen (% by Volume)[c]	VOC Destruction Efficiency, %[d]	Total NMHC[e] Destruction Efficiency, %	
		Inlet °F	Outlet °F	Ethylene	Ethylene Oxide	Ethane				Method 18	Method 25A
G-1	30,000	602	876	8706	199	1906	1.70	1.66	>99.9	>99.3	99.1
G-3	50,000	500	812	7988	187	1836	1.65	1.54	>99.4	>96.2	95.2
G-4	47,000	500	961	12,594	187	1735	2.60	2.22	>99.6	>99.1	99.1
G-2C	50,000	602	899	8499	207	1866	1.71	1.63	>99.5	>98.3	97.5
G-1C	30,000	602	876	8533	193	1877	1.70	1.63	>99.9	>99.4	98.9

[a] Run numbers with "C" designation represent measurement of catalyst destruction efficiencies. Other runs represent system destruction.

[b] Concentrations at system or catalyst inlet based on Method 18.

[c] Based on measured inlet concentrations and combustion calculations.

[d] Volatile organic compound (VOC) destruction efficiencies based on ethylene and ethylene oxide only.

[e] NMHC = non-methane hydrocarbons.

efficiencies for the ethylene oxide off-gas are estimated to be in the range of 3.5 to 4.5 percent.

The effect of oxygen content near the stoichiometric required level was found to have a very dramatic effect on destruction. At or above the stoichiometric oxygen concentration, VOC destruction efficiencies exceeded 99 percent and incinerator outlet CO concentrations were less than 1 ppmv. However, if the oxygen concentration dropped below the stoichiometric requirement, destruction efficiency dropped and outlet CO concentrations rose to in excess of 1,000 ppmv.

Comparison of destruction efficiencies observed for ethylene and ethylene oxide with those of other compounds tested with the large volume of catalyst A (Sections 7.2.2 and 7.3) suggests that ethylene and ethylene oxide are more easily destroyed on catalyst A than the other compounds. However, in comparing these data, it should be noted that the ethylene and ethylene oxide tests were conducted at much higher total mixture inlet concentrations. The higher inlet concentration would tend to result in higher destruction efficiency because of the higher average catalyst bed operating temperature.

7.8 PILOT UNIT VS. FULL-SCALE

In an earlier EPA study, performance data were collected on full-scale catalytic incinerators at six industrial sites.[1] To provide a comparison of destruction efficiencies obtained on the pilot unit with those of full-scale systems, the operating conditions of one of these incinerators were simulated during this study. The full-scale incinerator selected for this comparison treated exhaust gas from a foil coil coating line and used a catalyst equivalent to the catalyst A tested in this study.[8] The solvent mixture consisted of approximately 50 percent toluene and 50 percent methyl ethyl ketone (MEK) on a ppmv basis. Pilot tests with a toluene/MEK mixture (Mixture 2) were conducted at the same space velocity, inlet VOC concentrations, and three catalyst inlet temperatures characterized for the full-scale unit. The pilot tests were conducted with the smaller volume of catalyst A.

System destruction efficiencies for the pilot and full-scale tests are shown in Table 7-23. Also shown in Table 7-23 are the catalyst bed temperature rise and the expected temperature rise based on compound heats of combustion. The pilot and full-scale destruction efficiencies in Table 7-23 are in fairly good agreement, with the pilot data approximately 2 to 3 percent lower at all three test conditions. The difference between the pilot and full-scale results does not appear to be due to temperature effects because both catalyst beds showed similar catalyst outlet temperatures and similar heat losses.

One possible explanation for the difference between the pilot and full-scale efficiencies relates to the superficial gas velocity at the catalyst inlet. The superficial gas velocity for the full-scale system was 19 ft/sec compared with 11 ft/sec for the pilot-scale system at the inlet temperature of 640°F. As discussed in Section 7.2.1, data from this study for two volumes of catalyst A suggests that continued increase in the superficial velocity up to at least 13 to 16 ft/sec improves catalyst destruction efficiency.

In comparing the pilot and full-scale system data in Table 7-23, it should also be noted that the preheaters for the two incinerators were completely different. The full-scale system employs a natural gas-fired burner that directly contacts incoming solvent laden gases with the flame.

7.9 GC/MS RESULTS

A sample of the incinerator outlet gas was collected for GC/MS analysis in an effort to identify potential partial oxidation products from the catalytic incineration system (heater plus catalyst). This test run (C-38)

TABLE 7-23. PILOT AND FULL-SCALE RESULTS FOR MIXTURE 2

Type Of Data[a]	Mixture Inlet Concentration[b] (PPMC)	Catalyst Temperatures Inlet °F	Catalyst Temperatures Outlet °F	Catalyst Temperature Rise Measured °F	Catalyst Temperature Rise Calculated[c] °F	Method 25A System Destruction Efficiency, %
Full-Scale[d]	6,350	490	640	150	-	95.4
Full-Scale	10,420	540	785	245	335	97.1
Full-Scale	10,490	640	855	215	335	97.5
Pilot Unit	9,350	490	730	240	-	93.3
Pilot Unit	9,370	540	790	250	320	94.1
Pilot Unit	9,370	640	850	210	325	95.6

[a] All tests conducted at 40,000 hr^{-1} space velocity. Full-scale catalyst volume was 17.5 ft^3 and pilot-scale volume was 0.006 ft^3, both with Type A catalyst.

[b] Mixture consisted of approximately 50/50 toluene and methyl ethyl ketone on ppmc basis. Concentrations based on Method 25A, quantated against propane standards.

[c] Based on component heats of combustion and Method 18 destruction efficiencies.

[d] Reference 2. Catalytic incinerator applied to foil coil coating line, treating 11,300 scfm of waste gas.

was conducted with approximately 1,200 ppmC n-decane in air, at a space velocity of 50,000 hr^{-1} and an inlet temperature of 598°F. The system destruction efficiencies based on Methods 25A and 18 were 92.6 and 98.3 percent respectively. Results of the GC/MS analysis, which are presented in Table 7-24, identified at least 16 partial oxidation products in the incinerator exit gas. All of the compounds were found at concentrations below 0.5 ppmv.

7.10 CARBON MONOXIDE MEASUREMENTS

Carbon monoxide (CO) concentrations in the catalyst outlet gas were measured at each test condition throughout this program. During the testing with VOC/HAP mixtures in air, catalyst outlet CO concentrations were found to be less than 20 ppmv for all test runs, with over 171 of the 175 test runs showing concentrations of 5 ppmv or less. The higher catalyst outlet CO concentrations were measured during pure compound tests with n-hexane and n-octane at a space velocity of 50,000 hr^{-1} through the smaller catalyst A volume. Considerable fragmentation and partial oxidation of the alkanes was also observed during these tests as illustrated by the GC/MS results presented in Section 7.9.

No measurable concentrations of CO were found in the catalyst outlet gas during tests with the simulated ethylene oxide off-gas, provided that inlet O_2 levels were at or above the stoichiometric level. For periods when the O_2 level was below the stoichiometric requirements, CO values exceeded 1,000 ppmv.

During heater destruction efficiency testing, CO concentrations in the gas exiting the heater ranged from 5.0 to 350 ppmv. The CO concentration at the heater outlet was found to increase with increasing heater element temperature and/or heater destruction efficiency. Again, at conditions showing high CO concentrations, considerable fragmentation of input compounds to other unidentified compounds was observed at the heater outlet. These fragments were usually not detected, however, at the catalyst outlet.

TABLE 7-24. PARTIAL OXIDATION PRODUCTS IN INCINERATOR OUTLET GAS DURING TEST RUN C-38[a]

Compound	Molecular Weight	Identification Confidence[b]	Concentration (ppmv)[c]
Propene	(42)	2	0.24
Butene	(56)	2	0.36
Pentene	(70)	2	0.12
Acrolein	(56)	1	0.21
Acetone	(58)	1	0.29
Dimethoxymethane	(76)	2	0.04
3-Butane-2-one	(70)	2	0.06
Butanal	(72)	2	0.21
Methylethylketone	(72)	1	0.21
2-Methyl furan	(82)	3	0.03
Heptene	(98)	3	0.08
Pentanal	(86)	2	0.08
Octene	(112)	2	0.05
Hexanal	(100)	2	0.07
Heptanal	(114)	2	0.04
Decene	(144)	2	0.04
n-Decane	(146)	2	3.79

[a] Inlet gas to incinerator contained 1,278 ppmc pure n-decane in air. Method 18 destruction efficiency was 98.3 percent and Method 25A destruction was 92.6. Catalyst inlet temperature was 598°F and space velocity was 50,000 hr^{-1}.

[b] Confidence levels defined as follows: Level 1 - Compound is definitely present. Retention time and mass spectra match known standards. Level 2 - Compound is probably present. No retention time standard is available but mass spectra match well with library spectra. Level 3 - This compound represents the best guess for the data available. This could be identified as another compound with the same molecular weight.

[c] Concentration quanitated against toluene standard.

7.11 CATALYST BED TEMPERATURE RISE

Observed relationships between measured catalyst bed temperature rise and (1) the calculated or expected temperature rise and (2) the mass of solvent destroyed in the catalyst are discussed in this section. The usefulness of catalyst temperature rise as a monitoring tool is also briefly discussed.

Observed and expected catalyst bed temperature rises for Mixture 1 are presented in Table 7-25, along with total mixture catalyst destruction efficiencies and the mass of solvent destroyed in the catalyst. Expected temperature rises are based on compound heats of combustion and Method 18 destruction efficiencies. Data presented in Table 7-25 were collected with the larger volume of catalyst A.

Comparison of the percent difference between the observed and expected temperature rises in Table 7-25 at various operating conditions shows a trend of greater percent difference at higher catalyst inlet temperatures and lower system gas flow rates (space velocities). This trend indicates that heat losses from the catalyst shell were greatest under these operating conditions.

Comparison of catalyst bed temperature rise with catalyst destruction efficiencies shows no relationship between these variables. However, a trend of increasing temperature rise with increased mass of solvent destroyed is observed. Figure 7-19 shows plots of observed and calculated temperature rise versus the mass of solvent destroyed for Mixture 1. As shown in Figure 7-19, the difference between the calculated and observed temperature rise increases with decreasing mass of solvent destroyed.

Based on the relationship between observed temperature rise and the mass of solvent destroyed, temperature rise appears to be a useful means of monitoring catalytic incinerator performance. For a system operating on a

TABLE 7-25. CATALYST BED TEMPERATURE RISE DATA FOR MIXTURE 1

Run Number	Space Velocity (hr^{-1})	Catalyst Temperatures Inlet (°F)	Outlet (°F)	Observed Temperature Rise °F	Calculated Temperature Rise °F	Percent Difference In Rise	Catalyst Inlet Concentration[b] (ppmc)	Catalyst Destruction Efficiency, % Method 25A	Method 18	Mass of Solvent Destroyed[c] (lb/scf x 10^4)
E-1C	50,000	597	631	34	39	87	1,142	91.1	93.1	2.12
E-19C	50,000	797	818	21	34	61	991	96.3	95.7	1.91
E-3C	30,000	600	627	27	33	81	967	94.7	94.7	1.83
E-2C	30,000	698	717	19	29	65	838	96.8	>96.8	1.65
E-4C	30,000	798	812	14	26	54	731	97.7	>97.8	1.44
E-5C	20,000	600	617	17	30	57	849	96.6	>96.8	1.66
E-6C	20,000	699	706	7	23	30	654	97.8	>97.7	1.30
E-7C	15,000	597	611	14	28	50	786	98.2	>97.9	1.58

[a] Based on component heats of combustion and Method 18 destruction efficiencies.

[b] Based on Method 18 measurements.

[c] Mass of solvent destroyed per standard cubic foot of system inlet gas. Determined from Method 18 inlet concentrations and destruction efficiencies.

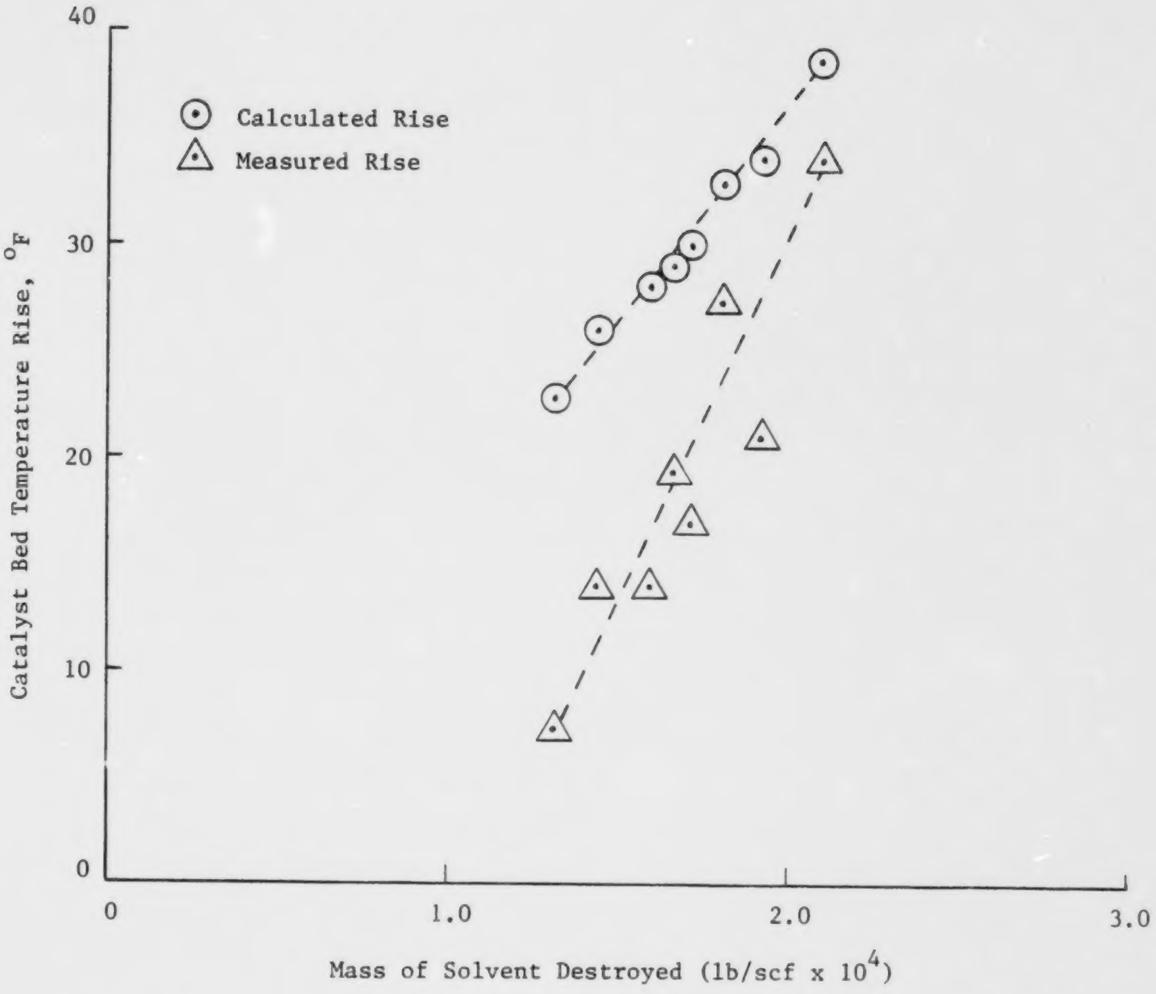

Figure 7-19. Temperature rise vs. mass of solvent destroyed - Mixture 1.

regular basis with similar inlet VOC concentrations, monitoring temperature rise would provide a continuous indication of the level of incinerator performance. The temperature rise could be measured during a single performance test and continuous operation of the incinerator at this same temperature rise would insure that the performance level measured during the test is being maintained. However, it should be recognized that the temperature rise, and potentially the destruction efficiency, will change with variation in inlet VOC concentration, catalyst inlet temperature, and system gas flowrate. Thus, for catalytic incinerators treating variable gas streams, temperature rise would not be an appropriate monitoring tool unless the inlet gas conditions during the performance test could be duplicated on a regular basis.

7.12 METHOD 18 VS. METHOD 25A

Mixture destruction efficiencies measured according to Methods 18 and 25A were compared for all data collected during this study. Results of the comparison showed very good agreement between the two test methods. A paired t-test showed the Method 18 destruction efficiencies to be 2.4 percent higher on average than those measured with Method 25A.

A difference of this magnitude would be expected, particularly for heater destruction efficiencies, because Method 18 destruction is based solely on the components entering the incinerator. Method 25A on the other hand measures both the remainder of input components and any partial oxidation products at the heater or catalyst outlet.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Results from this study identified or verified that the following factors affect the performance of catalytic incinerators:

- catalyst inlet temperature;
- space velocity;
- superficial gas velocity (at the catalyst inlet);
- catalyst geometry;
- compound type;
- inlet VOC concentration; and,
- mixture composition.

In addition, the testing verified that destruction efficiencies in the 98 to 99 percent range are achievable with catalytic incineration for the following compounds or classes at sufficiently low space velocities and/or high enough catalyst inlet temperatures:

- alcohols;
- acetates;
- ketones;
- cellosolve compounds/dioxane;
- aldehydes;
- aromatics; and
- ethylene/ethylene oxide.

Destruction efficiencies of at least 97 percent are also achievable for acrylonitrile and cresol, while chlorinated hydrocarbons appear unsuitable for control with the type of catalyst tested in this study. Other catalyst formulations might be more favorable for destroying chlorinated hydrocarbons.

Currently there is one area where information on catalytic incineration technology could be expanded with additional testing. This area involves the types of compounds for which catalytic incineration is applicable. While this study investigated a large number of compound classes, only a limited number of nonchlorinated HAP's could be tested. Further data on the applicability of catalytic incineration to the control of HAP's would be useful to the synthetic organic chemicals manufacturing industry and the various State and Federal agencies regulating this industry.

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APPENDIX A
ETHYLENE OXIDE PROCESS

In the United States two major processes are used in the manufacture of ethylene oxide (EO); oxidation of ethylene using air as the source of oxygen and oxidation using a pure oxygen source. In 1980 about 35 percent of the EO produced was made by the pure oxygen process while the remainder was made by the air based process. The following process description discusses the operating and emission characteristics of the most widespread process, air-oxidation. The main off-gas from the air-oxidation process was the gas stream simulated in this study.

A.1 PROCESS DESCRIPTION

In commercial processes the direct oxidation of ethylene to ethylene oxide is carried out in the vapor phase using oxygen as the oxidant with a silver catalyst. Figure A-1 is a flow diagram of a typical continuous air-oxidation processes. As shown in Figure A-1 ethylene and air (Streams 1 and 2) are added to a recycle stream (Stream 3), which feeds one or more primary reactors operated in parallel. The reaction temperature and pressure are maintained at 220 to 280°C and 1 to 3 MPa. The effluent from the primary reactor (Stream 4) is cooled by the recycle stream from the main absorber (Stream 3) to about 38°C in a shell-and-tube heat exchanger. It is then compressed before entering the main absorber. It passes up the main absorber countercurrent to cold water, in which the EO, along with some of the carbon dioxide from the stream, dissolves. The water solution is removed from the base of the main absorber (Stream 5).

Unabsorbed gas passing overhead from the main absorber is split into two unequal portions. The larger portion (Stream 3) recycles through the reactor effluent cooler and joins the fresh reactor feed. The smaller portion (Stream 6) is passed through a heat exchanger to raise its temperature and then enters the purge reactor (secondary ethylene conversion

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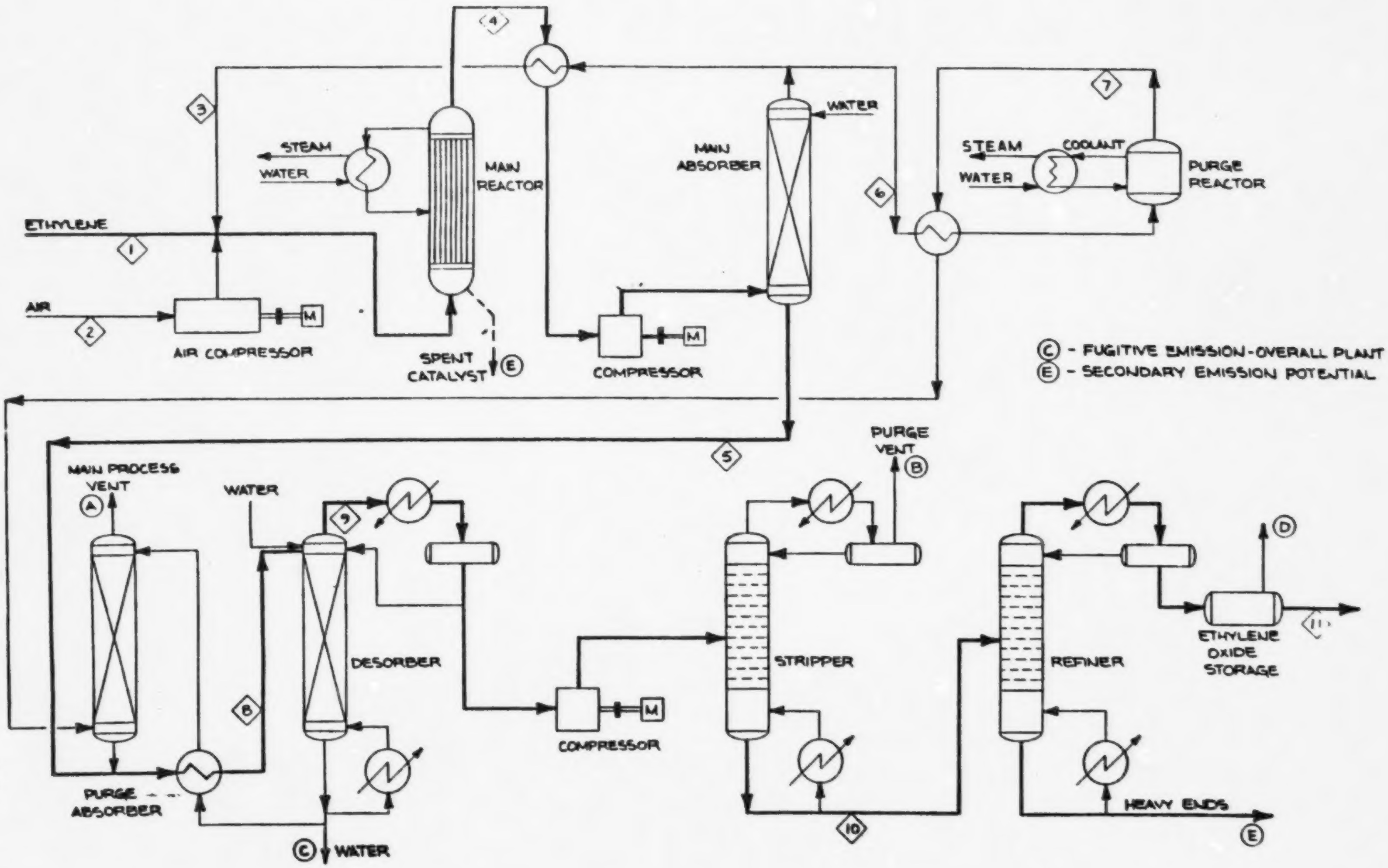
ETHYLENE
AIR
AIR COMPRESSOR
M
1
2
3
4
5
6
7
8
9
10
11
STEAM
WATER
MAIN REACTOR
SPENT CATALYST
E
COMPRESSOR
MAIN ABSORBER
WATER
STEAM
COOLANT
WATER
PURGE REACTOR
C - FUGITIVE EMISSION-OVERALL PLANT
E - SECONDARY EMISSION POTENTIAL
MAIN PROCESS VENT
A
PURGE ABSORBER
WATER
DESORBER
C
WATER
COMPRESSOR
PURGE VENT
B
STRIPPER
REFINER
HEAVY ENDS
E
D
ETHYLENE OXIDE STORAGE

Figure A-1. Flow diagram of a typical air-oxidation process manufacturing ethylene oxide.

reactor). The effluent from the purge reactor (Stream 7) is cooled by the incoming feed to the purge reactor and enters the purge absorber, where ethylene oxide is removed from the stream with water, as in the main absorber. The overhead from this absorber is the main process vent (Stream A). This vent is close to ambient temperature contains mostly nitrogen from the oxygen depleted air feed stream, and is relatively low in residual ethylene and ethylene oxide. It may be vented directly to the atmosphere or to a catalytic oxidizer for VOC control. When a catalytic oxidizer is used, hot gasses from the unit may be used to drive feed turbines for the process.

A.2 MAIN PROCESS VENT

The main process vent is the largest process emission source. In addition to containing nitrogen, ethylene and ethylene oxide, it also contains small amounts of unreacted oxygen and by-product carbon dioxide. Table A-1 shows the composition of a typical main process vent stream. Although these characteristics may vary from plant to plant, Table A-1 closely represents the vent characteristics of a typical plant using the process described here.

The composition of the main process vent depends on the catalyst and reactor conditions, ethylene feed purity, absorber operating conditions, and the number of purge reaction stages. Although Figure A-1 shows only one stage of purge reaction, there can be more. Large plants may increase the number of stages by incorporating additional purge reactors in series. Additional stages increase the freedom to optimize the reaction conditions. This results in an improved EO yield and reduced ethylene loss from the main process vent.

TABLE A-1. GAS COMPOSITION OF MAIN PROCESS VENT FROM A TYPICAL AIR-OXIDATION PROCESS[a]

Component	Composition (Wt. %)	Composition (Volume %)
Ethylene oxide	0.02	0.01
Ethylene	0.80	0.85
Ethane	0.09	0.09
Total VOC	0.91	0.95
Nitrogen	80.23	85.35
Oxygen	3.07	2.86
Carbon dioxide	15.65	10.60
Water	0.15	0.24
Total	100	100

[a] References 1 and 2.

A.3 PRESSURE EFFECT[3,4,5]

As discussed in Section 4.1.2, catalytic pilot tests with the simulated ethylene oxide off-gas were conducted at atmospheric pressure. To allow a comparison of the pilot test results with the more typical full-scale application at pressures near 100 to 200 psig, the effect of pressure on the catalytic oxidation of ethylene and ethylene oxide to CO_2 and H_2O was investigated. The results of this investigation are presented in this section.

For all of the combustion catalysts in commercial use, the rate of oxidation of a combustible component in the waste stream at any point within the catalyst bed can be described as being proportional to the concentration of the component in the waste stream at that point.[4] The rate of oxidation and conversion should be initially independent of the oxygen concentration of the waste stream, provided that this stream contains sufficient excess oxygen for complete oxidation.

The empirical observations are consistent with the following expression for the catalytic reaction rate:

$$r = k_{eff} C \qquad (1)$$

where k_{eff} is an average effective first order rate constant for oxidation and C is the concentration of the combustible component.

Empirical evidence suggests that there are two rate-limiting processes operating in series in catalytic reaction systems: (1) mass transfer of reactant hydrocarbon from the bulk gas stream to the catalyst surface and (2) an effective chemical reaction within the catalyst.[5] The rate of each process is first order in reactant hydrocarbon concentration. Thus, k_{eff} can then be represented by:

$$\frac{1}{k_{eff}} = \frac{1}{k_m} + \frac{1}{k_r} \qquad (2)$$

where k_m is the mass transfer rate constant and k_r, is the catalytic reaction rate constant. At the high temperatures employed in combustion, the catalytic reaction rate is very high and $1/k_r$ approaches 0. The overall reaction becomes limited by mass transfer rate and k_{eff} approaches the value k_m.

In general, different equations describing chemical and physical processes in a catalyst bed have to be solved simultaneously to determine concentration (or conversion), temperature, and pressure profiles. However, this analysis can be simplified by assuming isothermal operation in an ideal plug flow reactor. For this simplified case, the overall conversion of a combustible component can be expressed as:

$$f = 1 - \exp(-k_{eff} V/Q) \qquad (3)$$

where f = fractional conversion of the combustible component,
V = volume of catalyst bed,
Q = volumetric flowrate (actual).

It is noted that this expression does not take into account the temperature increase in the system due to heat released during the combustion reaction.

In Equation (3), the fractional conversion in a catalyst bed is determined by the effective reaction rate constant and the ratio of catalyst bed volume to the volumetric gas flowrate. The ratio of catalyst bed volume to gas flowrate is essentially the residence time of the gas in the catalyst bed. For a fixed catalyst volume, the parameters that are affected by changes in total pressure are k_{eff} and Q. As indicated earlier in this section, at high temperatures, $k_{eff} \approx k_m$. The mass transfer rate constant is a strong function of the diffusivity, especially in the laminar flow regime that is typical of catalytic combustion applications. Since diffusivity is inversely related to total pressure of the system,

$$k_{eff} \quad \alpha \quad \frac{1}{P_T} \qquad (3)$$

Thus, increasing the system pressure will cause the effective rate constant to decrease.

The volumetric flowrate of the gas stream at actual pressure conditions will also decrease at higher system pressure, leading to an increase in gas residence time. Since Q is inversely related to total pressure,

$$\frac{V}{Q} \quad \alpha \quad P_T \qquad (4)$$

Substitution of the relationships in equations A-3 and A-4 into equation A-2 indicates that the two key effects of pressure on the fractional conversion efficiency cancel. Hence, operation of the pilot unit at atmosphere pressure should have provided destruction efficiencies that are approximately the same as those that would be observed at the higher pressures.

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APPENDIX B

CONVERSION FACTORS

To Convert From English	To SI	Multiply By
cfm	m^3/hr	1.70
ft	m	0.305
in.	m	0.0254
in. H_2O	Pa	249
psi	Pa	6893
lb	kg	0.454
gal	m^3	3.79×10^{-3}
BTU	KJ	1.055

The temperature conversion formula between English and SI Units is:

$$\frac{°F - 32}{9} = \frac{°C}{5} \qquad \text{(B-1)}$$

Where: °F = degrees Fahrenheit

°C = degrees Celsius

APPENDIX C

QUALITY ASSURANCE/QUALITY CONTROL RESULTS

The test approach used in the pilot-scale investigation of catalytic incineration incorporated a comprehensive quality assurance/quality control (QA/QC) program as an integral part of the overall test program. The QA/QC program was designed to ensure that data collected would be complete, representative, and comparable to other similar data. It was also designed to control measurement data quality within prescribed limits of acceptability, and to ensure that the resulting data were of known quality with respect to precision and accuracy.

This section presents an assessment of the quality of the measurement data collected during this test program. This assessment is based upon QC data and performance audit results, and provides estimates of the uncertainty associated with the measurement data. Section C.1 presents conclusions and a brief summary of key QA/QC results. A discussion of the objectives of the QA/QC efforts, and the general approach used in achieving these objectives, is presented in Section C.2. Performance audit procedures and results are presented and discussed in Section C.3. Section C.4 addresses QC procedures and results.

C.1 SUMMARY AND CONCLUSIONS

Quality control data collected throughout the course of the measurement program, along with performance audit results, provide the basis for assessing the quality of the VOC/HAP destruction efficiency data. These qualifying data indicate that the measurement data are of adequate quality to fulfill the program objectives. Table C-1 presents measured values for precision and bias of the various measurements. Precision and bias

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TABLE C-1. SUMMARY OF ESTIMATED VS. MEASURED DATA QUALITY

Measurement Parameter	Method	Precision[a]		Bias[b]	
		Estimated[c]	Measured[d]	Estimated[c]	Measured[d]
VOC Destruction Efficiency	Calculated based on inlet and outlet concentrations	10%	e	—	±1%
VOC concentration (individual species and total VOC)	Method 18 (modified)	20%	11.4% (inlet) 8.9% (outlet)	±20%	-11% to +10%
VOC concentration (NMHC concentration only)	Method 25A (modified)	20%	7.4% (inlet) 7.2% (outlet)	±20%	-29% to + 3%
Catalyst Bed Temperature Rise	Difference between bed inlet and outlet temperatures	4°F	not determined	±6°F	
Inlet temperature	Thermocouple	3°F	not determined	±3°F	+3°F
Outlet temperature	Thermocouple	3°F	not determined	±3°F	+6°F
Carbon Monoxide Concentration	Continuous CO monitor	5%	3.0%	±5%	5%
Fixed Gas Concentration					
Oxygen		5%	2.4%	±5%	-8%
Carbon Dioxide		5%	2.1%	±5%	-6%
Nitrogen		5%	2.2%	±5%	-6%

[a] Coefficient of variation for repeat analyses (day-to-day variability).

[b] Bias (systematic error), expressed as a percentage of the measured value (i.e., relative error).

[c] Data quality objective presented in the Quality Assurance Project Plan.

[d] Measured precision (repeatability) based on observed variability in results.

[e] Program objectives required comparisons of average DE measured under different conditions. Observed differences between means were tested for significance using statistical techniques which take measurement variability (precision) into account. Bias was assumed to be negligible. Destruction efficiency data are presented in terms of confidence limits which reflect uncertainty in the measurement data.

objectives which were presented in the QA Project Plan for this project are shown for comparison

As indicated in Table C-1, overall uncertainty in the destruction efficiency measurements is estimated to be within ±1%, although precision and/or bias for some of the individual measurement parameters failed to meet the objectives presented in the QA Project Plan.

The data quality measurements presented in Table C-1 are average values and, as such, provide only a cursory glimpse of the data quality assessment performed for this project. The QA/QC program was designed to provide detailed information pertaining to the limitations associated with the measurement data. For instance, performance audit data for Method 25A indicate a strong correlation between measurement error and sample composition. Method 25A results for benzene, for example, were significantly better than results for MEK. While the performance audit results and QC data presented in the remainder of this section provide the primary basis for evaluation of uncertainty in the emission rate measurements, this evaluation requires careful interpretation of the audit and QC data in the context of the measurement data and the manner in which the individual measurement parameters are related.

C.2 QA/QC PROGRAM OBJECTIVES

For any measurement effort, there always exists some degree of uncertainty associated with the measurement data due to inherent limitations of the measurement system. The utility of the measurement data is dependent upon the degree to which the magnitude of this uncertainty is known and upon its relative impact. The pilot-scale catalytic incinerator testing described in this report included a comprehensive quality assurance/quality control (QA/AC) program. The objectives of the QA/QC efforts were twofold. First, they provided the mechanism for controlling data quality within acceptable limits. Second, they formed the basis for estimates of uncertainty by providing the necessary information for defining error limits associated with the measurement data.

The quality assurance function was organized to provide independent review and assessment of project activities and their ability to achieve the stated data quality objectives. The QA Coordinator for the project had the responsibility of evaluating the adequacy and effectiveness of the QC system and providing assurance that it was, in fact, responsive to the specific needs of the program.

In addition to reviewing the test plan and providing input into design of the QC efforts, the QA Coordinator implemented both performance and systems audits during the test program. The performance audits were designed to provide a direct, quantitative, point-in-time assessment of data quality in terms of accuracy. This was achieved by using equipment and standards which were independent of those used by the laboratory personnel. The systems audit was designed to provide a systematic, qualitative review and assessment of the critical elements of the various measurement systems and associated internal quality control (QC) systems, with emphasis upon procedures and documentation.

A quality control system is a system of routine internal procedures for assuring that the data output of a measurement system meets prescribed criteria for data quality. Inherent and implied in this control function is a parallel function of measuring and defining the quality of the data output. A well-designed internal QC program must be capable of controlling and measuring the quality of the data in terms of precision and accuracy, as well as ensuring that the data are complete, representative, and comparable. Precision reflects the influence of the inherent variability in any measurement system. Accuracy reflects the degree to which the measured value represents the actual or "true" value for a given parameter, and includes elements of both bias and precision. The precision and bias of the final data are related to the precision and bias of the component parts of the measurement system. While the QA activities served an evaluative function which was independent of the testing efforts per se, the QC system was an integral part of the daily technical effort. Together, the QC data and the audit results may be used to qualify the measurement data, as discussed in the remainder of this section.

C.3 QUALITY ASSURANCE AUDITS

As part of the quality assurance effort for this project, QA audits were conducted at two times during the testing. The first audit, performed February 20-21, 1984, addressed the VOC measurement systems, the CO monitor, and the temperature sensors. The second audit, performed May 23, 1984 during the ethylene oxide test series, focused specifically upon key measurements for these tests. These included fixed gas analyses in addition to VOC measurements. Both audits were performed by QA personnel using audit standards which were separate from those used for day-to-day testing. Audit procedures and results are discussed below.

C.3.1 VOC Measurements

Destruction efficiency was determined for the various test mixtures used in this program by measurements of organic vapor concentration in the incinerator inlet and outlet gas streams. Two independent methods were used for measuring volatile organic compound (VOC) concentration: Method 18 and Method 25A. Method 18 provides for quantitation of individual organic species following gas chromatographic separation of the sample gas components. Method 25A provides for VOC quantitation in terms of total (non-methane) hydrocarbon concentration as measured by an FID. Method 18 analyses were performed using a dual-column Tracor 560 gas chromatograph equipped with dual flame ionization detectors (FIDs). Separate sample loops and automated injection valves were used to permit simultaneous analysis of samples from the inlet and outlet gas streams. Two Byron Model 301 total hydrocarbon analyzers were used for inlet and outlet Method 25A measurements. For each test condition, separate destruction efficiency values were calculated using the Method 18 and Method 25A results. For the Method 18 data, destruction efficiency could be calculated for each of the components in the test mixture. Method 25A results, on the other hand, could only be used to calculate "overall" destruction efficiency based upon measured total hydrocarbon concentrations.

The initial performance audit of the Method 18 and Method 25A analyses was designed to fulfill two objectives. First, it was designed to provide estimates of bias in measured VOC concentrations. Second, and more important in terms of the overall test objectives, the audit was designed to provide data which could be used to estimate uncertainty in calculated destruction efficiencies. Since destruction efficiency represents a ratio between inlet and outlet VOC mass flow rates, bias in measured (i.e., calculated) destruction efficiency is a function of relative bias between inlet and outlet mass flow rate measurements. Error, or uncertainty, associated with any given destruction efficiency value reflects the combined effects of systematic error, or bias, and random error, or measurement variability. Since the volumetric flow rates at the inlet and outlet of the incinerator were the same, error in measured destruction efficiency simplifies to a function of error in the inlet and outlet concentration measurements. However, it is still the ratio of measured concentrations which is of concern, and interaction of inlet and outlet measurement error must be considered in estimating overall uncertainty in calculated destruction efficiencies.

The first objective of the performance audit was to quantitate bias in measured VOC concentrations for both Method 18 and Method 25A analyses. This part of the audit consisted of challenging the VOC analyzers with multiple concentrations of standard gas mixtures containing MEK and benzene. Since it was not practical to perform the audit using all the species used in test program, these two were chosen as representative species. Audit gas mixtures were obtained from both Scott Environmental Technology (MEK certified, ±2% accuracy) and from the U.S. EPA, Quality Assurance Division, Environmental Monitoring Systems Laboratory, Research Triangle Park, North Carolina (benzene QA audit materials). Multiple concentrations were obtained by dynamic dilution of the cylinder gas standards.

For Method 18 analyses, each component of the sample gas stream was quantitated separately. Quantitation was based on instrument response, as compared to a previously established response factor. This response factor, which was determined daily, was based on calibration against liquid mixtures of known concentration introduced at a known rate into a heated gas stream flowing at a known rate. Liquid concentration, injection rate, and volumetric flow rate of the gas stream were used to calculate a gas phase concentration for each species. Thus, the most likely source of bias in measured sample concentrations would be calibration error, due to error in the values used to calculate gas phase concentration of the calibration standard (e.g., injection rate, gas flow rate, etc.). Method 18 data for the cylinder gas audit are summarized in Table C-2.

As indicated in the table, error in the Method 18 data for MEK was within ±7%. For benzene, the measured values exhibited a low bias ranging from about -2% to -11%. These audit results indicate that the Method 18 data were easily within the ±20% objectives for bias presented in the QA Project Plan.

For Method 25A analyses, the total VOC content of the sample gas stream was quantitated as total hydrocarbon (THC) in parts per million by volume as carbon (ppmv-C). Quantitation was based on instrument response factors derived by calibration against propane gas mixtures. The Byron analyzers used for Method 25A analyses use a flame ionization detector (FID) as specified in the method. Since FID response is species-dependent, differences between response to propane and response to a given sample gas mixture would be expected to be the primary source of error in the Method 25A data. The cylinder gas audit results for Method 25A, which are summarized in Table C-3, were consistent with this expectation. For MEK, the audit results indicated bias of about -15% to -22% (low). Benzene results, on the other hand, were better, with bias within ±3%. The larger error for MEK is consistent with inherently poorer FID response to oxygenated species.

TABLE C-2. METHOD 18 CYLINDER GAS AUDIT RESULTS

		Inlet					Outlet				
			Response (ppmv-C)		Relative Error (%)			Response (ppmv-C)		Relative Error (%)	
Audit Gas	Concentration (ppmv-C)	No. of Trials	Mean	Standard Deviation	Mean	(95% C.I.)	No. of Trials	Mean	Standard Deviation	Mean	(95% C.I.)
Zero Air	0	2	0	0	-	-	2	0	0	-	-
MEK	47.5	6	45.9	0.5	-3.4	±1.1	6	44.2	0.2	-6.8	±0.4
MEK	97.0	6	97.8	0.4	0.9	±0.4	6	93.3	0.8	-3.8	±0.9
MEK	521.2	6	514.0	0.6	-1.4	±0.1	6	492.7	2.1	-5.5	±0.4
MEK	1067.8	5	1121.0	24.1	5.0	±2.8	5	1090.8	30.3	2.2	±3.5
MEK	1914.1	4	1892.0	14.1	-1.2	±1.2	4	1825.5	14.4	-4.6	±1.2
MEK	3892.0	6	4007.7	13.3	3.0	±0.4	6	3970.0	18.4	2.0	±0.5
Benzene	67.2	6	65.7	0.5	-2.2	±0.7	6	63.8	0.6	-5.1	±0.9
Benzene	321.4	6	299.7	1.9	-6.8	±0.6	6	287.5	3.8	-10.5	±1.2
Benzene	672.0	6	647.0	1.1	-3.7	±0.2	6	614.0	7.2	-8.6	±1.1

TABLE C-3. METHOD 25A CYLINDER GAS AUDIT RESULTS

		Inlet					Outlet				
			Response (ppmv-C)		Relative Error (%)			Response (ppmv-C)		Relative Error (%)	
Audit Gas	Concentration (ppmv-C)	No. of Trials	Mean	Standard Deviation	Mean	(95% C.I.)	No. of Trials	Mean	Standard Deviation	Mean	(95% C.I.)
Zero Air	0										
MEK	47.5	5	33.7	0.3	-29.1	±0.7	5	37.1	0.3	-21.9	±0.7
MEK	97.0	4	73.3	2.3	-26.4	±3.7	4	81.8	3.7	-15.6	±6.0
MEK	521.2	3	415.0	0	-20.4	±0.0	3	422.7	10.4	-18.9	±5.0
MEK	1067.8	5	888.4	17.8	-16.8	±2.1	4	904.8	20.0	-15.3	±3.0
MEK	1914.1	4	1569.8	55.4	-18.0	±4.6	3	1586.7	42.7	-17.1	±5.5
MEK	3892.0	3	3303.0	86.6	-15.1	±5.5	5	3212.2	73.4	-17.5	±2.3
Benzene	67.2	6	65.1	1.1	-3.2	±1.7	5	68.9	2.0	2.5	±3.8
Benzene	321.4	4	299.1	2.5	-7.0	±1.2	5	318.3	4.1	-1.0	±1.6
Benzene	672.0	5	688.2	8.7	2.4	±1.6	5	654.4	13.6	-2.6	±2.5

The second objective of the performance audit was to estimate uncertainty in the destruction efficiency measurements. For this part of the audit, liquid audit standards were used. Three different audit mixtures were prepared. Each mixture contained isopropanol (IPA), methylethyl ketone (MEK), ethyl acetate, benzene, and hexane. These solvents were chosen as representative of the different classes of compounds evaluated in the incineration tests. The first mixture (Mixture #1) contained the five solvents at an approximately 1:1:1:1:1 ratio with respect to concentration on a carbon basis (i.e., ppm-C). Mixture #2 was prepared at a ratio of 1.5:1.0:1.5:1.0:2.6 for the five components, respectively. For Mixture #3, the ratio was 2:2:3:1:5. The Method 18 and Method 25A analytical systems were challenged with each of the three mixtures successively injected into a heated gas stream flowing at a known rate. A total of four different liquid injection rates were used, with three rates used for each mixture. In this manner, nine different test atmospheres were generated, each containing a different concentration of the five components. Composition data for the nine test atmospheres are presented in Table C-4, along with liquid concentrations, injection rate, and gas flow rates used to calculate gas phase concentrations.

Inlet and outlet measurement systems (i.e., Method 18 and Method 25A instrumentation) were set up so that "inlet" and "outlet" measurements were made simultaneously by both systems on each test atmosphere. A computerized data reduction routine was used to combine "inlet" data for one test atmosphere with "outlet" data for a different test atmosphere and calculate simulated "destruction efficiencies." These "measured destruction efficiency" values were then evaluated by comparison to corresponding "actual destruction efficiency" values which were calculated based on actual gas phase concentrations. Actual gas phase concentrations for the different test atmospheres were calculated as described above, based on liquid concentration, injection rate, and gas flow rate.

An example is helpful to clarify the procedure used. Referring to Table C-4, the actual gas phase concentration of IPA in Test Atmosphere #1C

TABLE C-4. COMPOSITION OF TEST ATMOSPHERES

Mixture No.	Test Atmosphere	Liquid Injection Rate (ml/min)	Gas Flow Rate (SCFM)	Component	Liquid Concentration (g/ml)	Component Gas Phase Concentration (ppmv-C)	Total Gas Phase Concentration (ppmv-C)
1	1A	0.478	12.30	IPA	0.179	301	
				MEK	0.164	302	
				EtOAc	0.202	303	
				Benzene	0.118	304	
				Hexane	0.132	305	1,515
1	1B	0.933	12.30	IPA	0.179	588	
				MEK	0.164	589	
				EtOAc	0.202	592	
				Benzene	0.118	593	
				Hexane	0.132	595	2,958
1	1C	1.81	12.30	IPA	0.179	1141	
				MEK	0.164	1144	
				EtOAc	0.202	1149	
				Benzene	0.118	1157	
				Hexane	0.132	1154	5,738
2	2A	0.478	12.30	IPA	0.174	290	
				MEK	0.107	198	
				EtOAc	0.194	296	
				Benzene	0.077	197	
				Hexane	0.219	506	1,487
2	2B	0.933	12.30	IPA	0.174	556	
				MEK	0.107	387	
				EtOAc	0.194	577	
				Benzene	0.077	385	
				Hexane	0.219	988	2,903
2	2C	0.059	12.17	IPA	0.174	36.1	
				MEK	0.107	24.7	
				EtOAc	0.194	36.8	
				Benzene	0.077	24.6	
				Hexane	0.219	63.1	185.2
3	3A	0.478	12.30	IPA	0.135	226	
				MEK	0.123	228	
				EtOAc	0.223	337	
				Benzene	0.044	113	
				Hexane	0.242	561	1,466
3	3B	0.933	12.30	IPA	0.135	442	
				MEK	0.123	446	
				EtOAc	0.223	658	
				Benzene	0.044	221	
				Hexane	0.242	1095	2,862
3	3C	0.059	12.17	IPA	0.135	28.2	
				MEK	0.123	28.4	
				EtOAc	0.223	42.0	
				Benzene	0.044	14.1	
				Hexane	0.242	69.9	182.6

was 1141 ppmv-C. In Test Atmosphere #3C, the IPA concentration was 28.2 ppmv-C. If the #1C concentration is used to represent an inlet value and the #3C concentration is taken as the corresponding outlet value for this simulated test, this would represent a "destruction efficiency" of 97.5% (i.e., [1-(28.2/1141)] x 100). Now, assume that during the #1C test, an IPA concentration of 1160 ppm-C was measured by the inlet Method 18 system. Also assume that during the #3C test, the measured IPA concentration was 32 ppmv-C for the outlet Method 18 system. Combining these measured values yields a "measured" destruction efficiency of 97.2%. The difference between "actual" destruction efficiency and "measured" destruction efficiency is -0.3% (i.e., 97.5%-97.2%). Using the computerized data reduction system mentioned above, this procedure was used to calculate 32 error estimates for each species.

A restriction was used in the routine so that "inlet" and "outlet" values were always based on results obtained for different liquid mixtures. In other words, two test atmospheres generated using the same liquid mixture were never used together as inlet and outlet values. The purpose of this restriction was to make the simulation more representative of actual test conditions. Since components in a test mixture would exhibit varying destruction efficiencies, the inlet and outlet gas streams would be expected to contain different ratios of the various components. This would not have a significant impact upon Method 18 determinations where samples are speciated and each component is quantitated separately using individual response factors. Different component ratios would, however, be expected to impact destruction efficiency estimates based on Method 25A measurements where the individual components are not separated and an average response factor is used.

An additional restriction in the computer simulation routine required that the mean values be calculated using only non-negative values for "actual destruction efficiency." Thus, cases in which a selected combination had an outlet value greater than the inlet value were rejected.

Results of the computer simulation of uncertainty in measured destruction efficiency are presented in Table C-5. The number of simulated cases used for each species is indicated in the table. The simulations indicated that average error in measured destruction was generally within ±1% for both methods. Different ratios of components in the inlet and outlet gas streams appeared to have little effect on destruction efficiency estimates, as indicated by comparable error values for the two different methods.

C.3.2 Ethylene Oxide Tests

A second performance audit of the VOC measurement systems was conducted May 23, 1984 during the ethylene oxide testing. The sampling/analytical system used during this series of tests was essentially the same as that used for previous tests, with respect to Method 18 and Method 25A measurements. However, for this test series, cylinder gas mixtures containing the species of interest were used for instrument calibration. The performance audit consisted of challenging the measurement systems with audit gas mixtures containing ethylene oxide, ethane, and ethylene at concentrations comparable to those in the incinerator inlet and outlet gas streams. Multiple concentrations were obtained by dynamic dilution of a gravimetric master standard gas mixture (certified ±1% accuracy) obtained from Scott Environmental Technology. The dilution system used in the audit was calibrated just prior to the audit using an NBS-traceable soap bubble flow meter. Audit results for both measurement methods (i.e., Method 18 and Method 25A) are summarized in Table C-6. Detailed results are presented in Table C-7 for Method 18 and in Table C-8 for Method 25A.

Mean values for relative error in Method 18 measurements were easily within ±20% bias objectives for ethane and ethylene, as indicated in Table C-7. For ethylene oxide, measurements at both the inlet and outlet met the ±20% bias criterion, but a significant relative bias between inlet and outlet measurements was observed. This probably had little impact on actual destruction efficiency measurements, however, since ethylene oxide was generally not detected in the outlet gas stream during efficiency

TABLE C-5. UNCERTAINTY IN MEASURED DESTRUCTION EFFICIENCY

Method	Species	Mean Error in Measured Destruction Efficiency	Standard Deviation	Number of Observations
18	Benzene	-1.06%	2.37%	25
18	Ethyl Acetate	-0.99%	2.08%	27
18	Hexane	0.14%	2.16%	26
18	Isopropanol	-0.48%	2.14%	26
18	Methylethyl Ketone	-0.36%	1.63%	27
18	Total Hydrocarbon	-0.57%	1.91%	26
25A	Total Hydrocarbon	0.34%	3.02%	26

TABLE C-6. SUMMARY OF VOC AUDIT RESULTS FOR ETHYLENE OXIDE TESTING

Instrument (Method)	VOC Measurement System	Parameter	Range Audited[a] (ppm)	Mean Relative Error (%)	Standard Deviation (ppm)	Number of Audit Points
Method 18	Inlet	Ethylene	74.0 to 7472.6	-2.4	0.9	5
		Ethane	8.16 to 823.5	-4.8	8.6	5
		Ethylene Oxide	1.09 to 109.8	10.4	2.9	5
Method 18	Outlet	Ethylene	74.0 to 7472.6	-2.8	1.8	5
		Ethane	8.16 to 823.5	-6.8	5.0	5
		Ethylene Oxide	1.09 to 109.8	-5.8	4.0	5
Method 25A	Inlet	Total Hydrocarbon[b]	166 to 16,814	-19.6	4.5	5
Method 25A	Outlet	Total Hydrocarbon[b]	166.5 to 7830.8	-13.8	4.5	3

[a] Range of upscale audit concentrations, not including zero points for all parameters.

[b] Total hydrocarbon concentration expressed in terms of ppmv-C (parts per million by volume as carbon) relative to propane calibration standard.

TABLE C-7. METHOD 18 AUDIT RESULTS FOR ETHYLENE OXIDE TESTING

Component	Input Concentration	Inlet Mean Measured Concentration	Inlet Relative Error	Outlet Mean Measured Concentration	Outlet Relative Error
Ethylene	74.0	70.1	-5.27	72.0	-2.70
	544	530	-2.57	529	-2.78
	1390	1357	-2.37	1366	-1.73
	3481	3427	-1.55	3470	-0.32
	7473	7345	-1.71	7200	-3.65
Ethane	8.16	7.83	-4.04	7.85	-3.80
	59.9	58.2	-2.84	58.3	-2.67
	153	157	2.61	150	-1.96
	384	329	-14.3	357	-7.03
	824	714	-13.3	759	-7.89
Ethylene Oxide	1.09	ND	-	ND	-
	8.00	8.66	8.25	7.24	-9.50
	20.4	22.3	9.31	19.7	-3.43
	51.1	56.4	10.4	46.6	-8.81
	110	126	14.5	108	-1.82

TABLE C-8. METHOD 25A AUDIT RESULTS FOR ETHYLENE OXIDE TESTING

	Inlet		Outlet	
Input Concentration (ppm)	Measured Concentration (ppm)	Relative Error (%)	Measured Concentration (ppm)	Relative Error (%)
166	121	-27.1	138	-16.9
1224	1013	-17.2	1032	-15.7
3127	2513	-19.6	NA	-
7832	6513	-16.8	7154	-8.6
16814	13910	-17.3	NA	-

testing. The audit data do indicate that a reasonable detection threshold was obtained for ethylene oxide (between 1 and 8 ppm) and that measured destruction efficiencies in excess of 99% are reliable.

Tables C-6 and C-8 both indicate that Method 25A concentration measurements were within the ±20% bias objectives specified in the QA Project Plan. For both the inlet and outlet measurement systems, measured THC concentrations were biased low as a result of the difference in FID response to the propane calibration standard and response to the ethylene/ethane/ethylene oxide gas mixture. However, since relative bias between inlet and outlet measurements was small (average <6%), the impact on destruction efficiency measurements should also have been relatively small, as demonstrated during the initial audit (see previous section).

C.3.3 Fixed Gas Analyses

A Fisher Model 1200 Gas Partitioner was used during the ethylene oxide testing to measure carbon dioxide (CO_2), oxygen (O_2), and nitrogen (N_2) in the incinerator inlet gas stream. This measurement system was audited during the second performance audit by challenging the system with audit gas mixtures of CO_2, O_2, and N_2. As for the audit of the VOC measurement systems, test atmospheres were generated at several concentrations by dilution of a high concentration standard gas mixture containing the components of interest. Results are summarized in Table C-9.

The primary purpose of the fixed gas analyses for the ethylene oxide testing was to monitor oxygen concentration in the test gas stream. Measured O_2 levels were then compared to stoichiometric concentrations. Although the audit results indicate that measurement data for all three parameters failed to meet the bias objectives presented in the QA Plan, O_2 results at concentrations comparable to those actually measured during the ethylene oxide testing (1% to 3%) were well within specified limits (±0.5% absolute or ±5% relative error, whichever is greater).

TABLE C-9. FIXED GAS AUDIT RESULTS

Parameter	Input Concentration (%)	Measured Concentration (%)	Error (%)	Relative Error[a] (%)
O_2	1.22	1.19	-0.03	-2.4
	4.02	3.96	-0.06	-1.5
	9.28	7.70	-1.58	-17.0
	10.2	10.0	-0.2	-2.0
	12.2	10.9	-1.3	-10.6
	14.9	13.4	-1.5	-10.1
	17.4	15.1	-2.3	-13.2
		Mean	-1.0	-8.1
		S.D.	0.9	6.2
CO_2	0.92	0.91	-0.01	-1.1
	6.96	6.20	-0.76	-10.9
	9.15	8.74	-0.41	-4.5
	11.2	10.4	-0.8	-7.1
	13.1	12.0	-1.1	-8.4
		Mean	-0.6	-6.4
		S.D.	0.4	3.8
N_2	69.5	59.5	-10.0	-14.4
	73.9	66.6	-7.3	-9.9
	78.6	70.0	-8.6	-10.9
	83.6	66.1	-17.5	-20.9
	89.8	98.4	8.6	9.6
	96.0	98.9	2.9	3.0
	97.9	92.0	-5.9	-6.0
	100	101.4	1.4	1.4
		Mean	-4.6	-6.0
		S.D.	8.3	10.1

---

[a] Error expressed as a percentage of the input concentration.

Results for N_2 presented in Table C-9 were based on direct measurements. Because these data and QC data for N_2 analyses indicated excessive instrument drift for this parameter, N_2 values used during actual testing were determined by difference using the O_2 and CO_2 data.

C.3.4 Carbon Monoxide Analyses

Carbon monoxide (CO) concentration was continuously monitored on the incinerator outlet stream using a Bendix nondispersive infrared gas analyzer. This measurement system was audited during the first performance audit conducted in February. The audit consisted of challenging the instrument with test atmospheres containing several different concentrations of CO, over the range of zero to approximately 50 ppm. As was done for the audits of the VOC and fixed gas measurement systems, individual audit mixtures were prepared by dynamic dilution of a high concentration standard gas mixture. Audit results are shown in Table C-10. As indicated in the table, measured CO concentrations were within 1 ppm of the input value at all points except the highest. At the highest audit point (47.5 ppm), instrument response was 2.4 ppm low.

C.3.5 Temperature Measurements

Thermocouples interfaced to digital temperature readouts were used to monitor temperature of the inlet and outlet gas streams. A K-type thermocouple system was used at the inlet while a J-type system was used at the outlet. Both temperature measurement systems were audited using a reference standard precision voltage source to input voltages corresponding to specific temperatures over the range of interest. Average error was 3°F (high) at the inlet over the range from 32°F to 1009°F. For the outlet system, average error was 6°F (high) over the range from 400°F to 1009°F. Results for both the inlet and outlet systems are presented in Table C-11.

TABLE C-10. CARBON MONOXIDE AUDIT RESULTS

Input Concentration (ppm)	Instrument Response (ppm)	Error (ppm)	Relative Error (%)
0	0.9	0.9	----
1.95	2.3	0.4	17.9
9.13	9.7	0.6	6.2
25.3	26.0	0.7	2.8
47.5	45.1	-2.4	-5.1
	Mean	0.0	5.4
	Standard Deviation	1.4	9.6

TABLE C-11. TEMPERATURE AUDIT RESULTS

Input Temperature (°F)	Inlet Measured Temperature (°F)	Inlet Error (°F)	Outlet Measured Temperature (°F)	Outlet Error (°F)
32	36	4	ND	-
400	ND	-	403	3
428	452	4	433	5
509	511	2	514	5
617	620	3	621	4
727	729	3	732	5
806	809	3	812	6
942	945	3	952	9
1009	1013	3	1018	9
	Mean	3.1	Mean	5.8
	Standard Deviation	0.6	Standard Deviation	2.2

C.4 QUALITY CONTROL DATA

The major focus of the data quality control effort for this program was to:

- control and assess day-to-day variabiilty,
- control and assess relative bias between the inlet and outlet instruments, and
- control and assess instrument response drift.

This section presents the quality control data gathered for each instrumental analysis method used during the bench-scale catalytic incinerator testing.

C.4.1 Method 18 QC Data

Day-to-day variability, relative bias between the inlet and outlet instruments, and within-day instrument response drift for Method 18 were determined by analysis of a control standard gas. These analyses were conducted at two different times each day: prior to testing and after calibration (pretest), and at the conclusion of the testing (posttest). The pretest check consisted of three analyses of the control standard, serving as QC check of within-day variability (of individual measurements), as well as day-to-day variability (of average values). The control limit for these replicate analyes was a CV of $\leq$5%. A single analysis of the control standard served as the posttest check. Ideally, a single standard is used as the control standard for the duration of an analytical program. However, Method 18 and 25A instrumentation shared control standards for this program and several different gas standards were ultimately required to complete the program due to a high rate of gas standard consumption.

The major function of the control standard analyses was to assess day-to-day variability for the inlet and outlet instruments. Figure C-1 presents control sample data for the inlet instrument. To faciliate comparison of data for different standards, results are expressed in terms of percent recovery. Percent recovery was calculated by expressing the measured concentration as a percentage of the actual concentration of the control standard. Control standard data for the outlet instrument are presented in Figure C-2. Results for both instruments tended to be within the ±10% window prescribed by the QAPP on those days for which a calibration (either multipoint or single point) was performed using a standard containing the same species as used for the control standard. Overall variability, expressed in terms of the pooled coefficient of variation (CV) for the control standard recovery was 11.4% for the inlet instrument and 8.93% for the outlet instrument. The ±10% acceptance limits were exceeded 2 times for the inlet instrument on days when calibrations were performed using the control sample species. The outlet instrument control sample analyses exceeded the control limits on eight days when such calibrations were performed.

A second function of the control standard analyses was to assess relative bias between the inlet and outlet measurement systems. Since the same control standard was used for both systems, bias could be assessed directly, based on the difference in response between the two systems. The primary control function of this QC check was to ensure that neither system, when challenged with the same test atmosphere, generated measurement data which were consistently higher or lower than the other. The effect of a consistent difference would be to impart systematic error to the destruction efficiency measurements. Random variability in the magnitude and direction (i.e., sign) of this difference was taken into consideration in the overall experimental design.

Since the actual value of the control standard was known, it was possible to quantitate relative bias in terms of the true value on days in which the control standard species (MEK or toluene) was in the calibration mixture. Relative bias was calculated as the outlet relative error (i.e.,

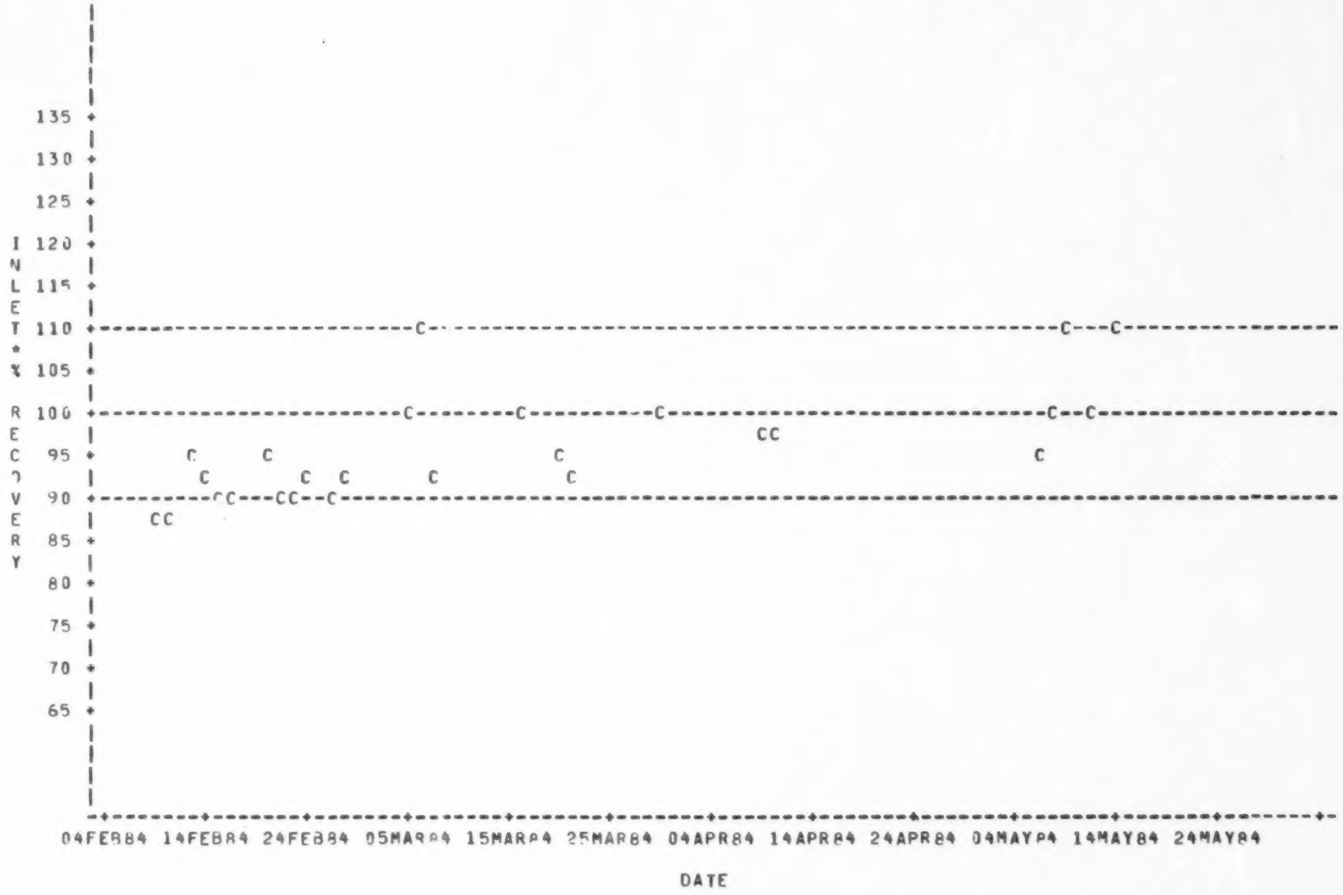


Figure C-1. Method 18--Pretest Inlet QC Data.

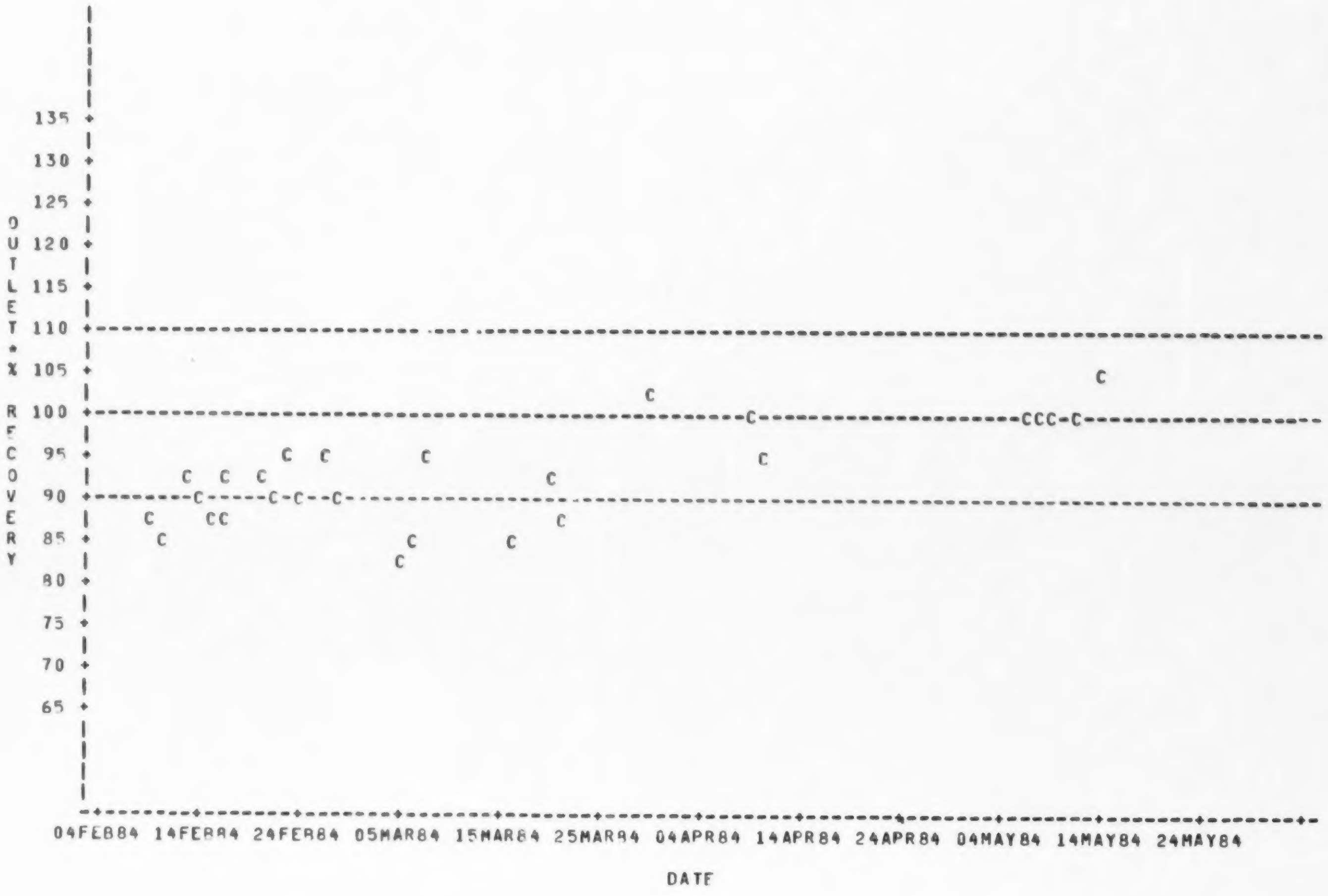


Figure C-2. Method 18--Pretest Outlet GC Data.

percent recovery minus 100) minus the inlet relative error. So, for a control standard of 150 ppmv-C, with a measured inlet value of 165 ppmv-C and a measured outlet value of 180 ppmv-C, relative bias would be calculated as:

$$\text{Relative Bias}_{(\text{Outlet to Inlet})} = \left[\frac{(180-150)100}{150}\right] - \left[\frac{(165-150)100}{150}\right]$$
$$= 10\%$$

On days in which the control standard species was not in the calibration mixture, measured values were calculated using the average system RF for that day. For purposes of calculating a relative bias value, the "true" value used in the above calculation was the average of the inlet and outlet values. This allowed the direction of bias to be established as negative or positive, and gave an estimate of "average" magnitude for comparison to other data.

The degree of relative bias between the inlet and outlet measurement systems is directly related to uncertainty in measured destruction efficiency. The magnitude of this effect (i.e., the degree of uncertainty) depends, however, upon four interrelated factors:

- magnitude of the relative bias,
- direction of the bias (i.e., positive or negative),
- the relative contribution of bias in the inlet as compared to the outlet, and
- destruction efficiency (i.e., the relative difference between inlet and outlet concentrations).

Generally, uncertainty in measured destruction efficiency increases with increasing relative bias between the inlet and outlet measurement systems. The effect is strongly related to destruction efficiency, however. At high destruction efficiencies (>95%), the effect of even large relative bias (>30%) is relatively small. An example is helpful to put this effect into perspective. Consider a hypothetical test in which the true inlet concentration of ethyl acetate is 250 ppmv-C and the true outlet concentration is 5.0 ppmv-C. The actual destruction efficiency is therefore 98.0%. If both the inlet and outlet measurements were biased high by 10%, measured values would be 275 ppmv-C and 5.5 ppmv-C, respectively. Although both instruments would be biased with respect to the true values, relative bias between the two would be zero. Consequently, the calculated destruction efficiency would still be 98.0%. If, however, the inlet instrument were biased high by 10% and the outlet by 15%, relative bias between the two would be 5.0%. Measured values would be 275 ppmv-C and 5.75 ppmv-C for a calculated destruction efficiency of 97.9%. Here, a relative bias of 5.0% results in an error of -0.1% in measured destruction efficiency. For the same relative bias at a lower destruction efficiency, such as 70%, the impact is significantly greater. Using the same true inlet value, 250 ppmv-C, an outlet value of 75.0 ppmv-C represents 70.0% destruction efficiency. The biased measurements would be 275 ppmv-C and 86.25 ppmv-C for a calculated destruction efficiency of 68.6%. Here the measurement error for DE is -1.4%.

At high destruction efficiencies, the effect of even large relative bias is diluted. At 95% actual destruction efficiency, a relative bias of 50% between inlet and outlet measurements results in no more than ±5% error in measured destruction efficiency. At 50% actual destruction efficiency, a relative bias of 50% would result in measured destruction efficiencies in error by as much as 50%. As indicated above, the direction of the relative bias and the relative contributions of the two measurement systems also influence uncertainty in measured destruction efficiency. For Method 18 pretest control sample analyses, relative bias ranged from -35.0% to 23.0% with a mean of -2.5% and standard deviation of 9.4%. These data are presented in Figure C-3.

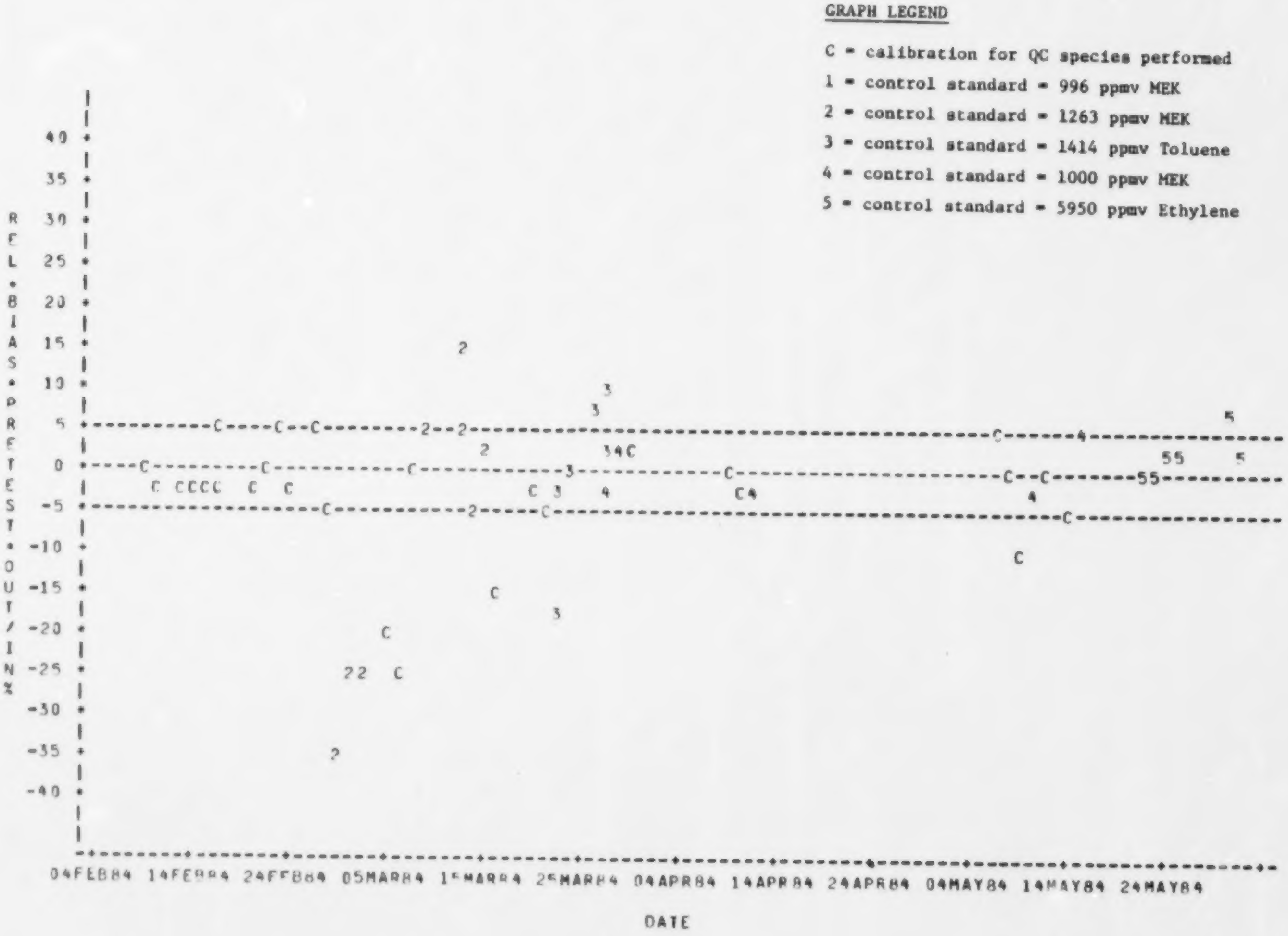


Figure C-3. Method 18--Pretest Relative Bias Data.

At the end of testing each day, the control standard was again analyzed by the inlet and outlet instruments. These posttest analyses were used to determine instrument drift (within-day). Instrument drift was determined for each instrument as the difference between posttest and pretest (i.e., posttest minus pretest) control sample analyses values expressed as a percentage of the pretest value. Drift ranged from -15% to +14.7% for the inlet instrument, with a mean of 1.8% These data are presented in Figure C-4. Outlet instrument drift ranged from -6.5% to 11.1% with a mean drift of 0.5%. These data are presented in Figure C-5. The Method 18 inlet instrument exceeded the ±5% acceptance limits for drift on nine occasions while the outlet instrument exceeded the drift limits on only five.

The posttest control sample data may also be used to evaluate relative bias between the instruments, as was done using the pretest data. Results using these data are comparable to the other estimates with bias ranging from -35.0% to 14.6%. Mean relative bias using these data was -4.3%. These data are presented in Figure C-6.

C.4.2 Method 25A QC Data

Quality control checks for Method 25A analyses were essentially the same as those described above for Method 18. Each day, a control standard gas mixture was analyzed before and after testing to determine day-to-day variability, relative bias between inlet and outlet measurement systems, and within-day calibration drift.

Several different control standard gas mixtures, containing different species at different concentrations, were used over the course of the test program. Results for the control sample analyses are presented graphically in Figures C-7 and C-8 for the inlet and outlet instruments respectively. Since data are presented for the different control standards, results are presented in terms of percent recovery (Y-axis). Different standards are distinguished by different numbers on the graphs, as indicated in the legend grouping the data by species used for the control standard. Day-to-day

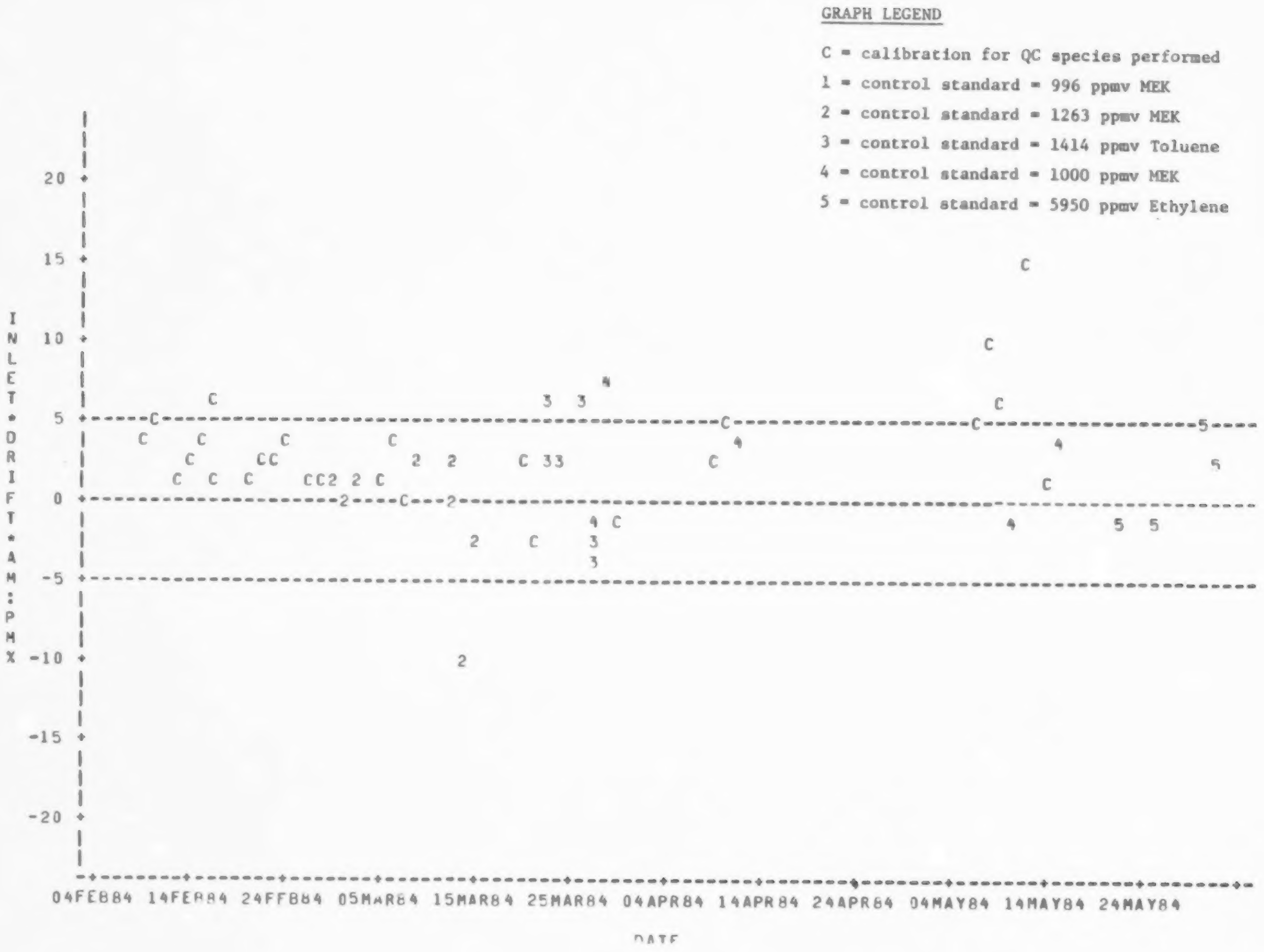
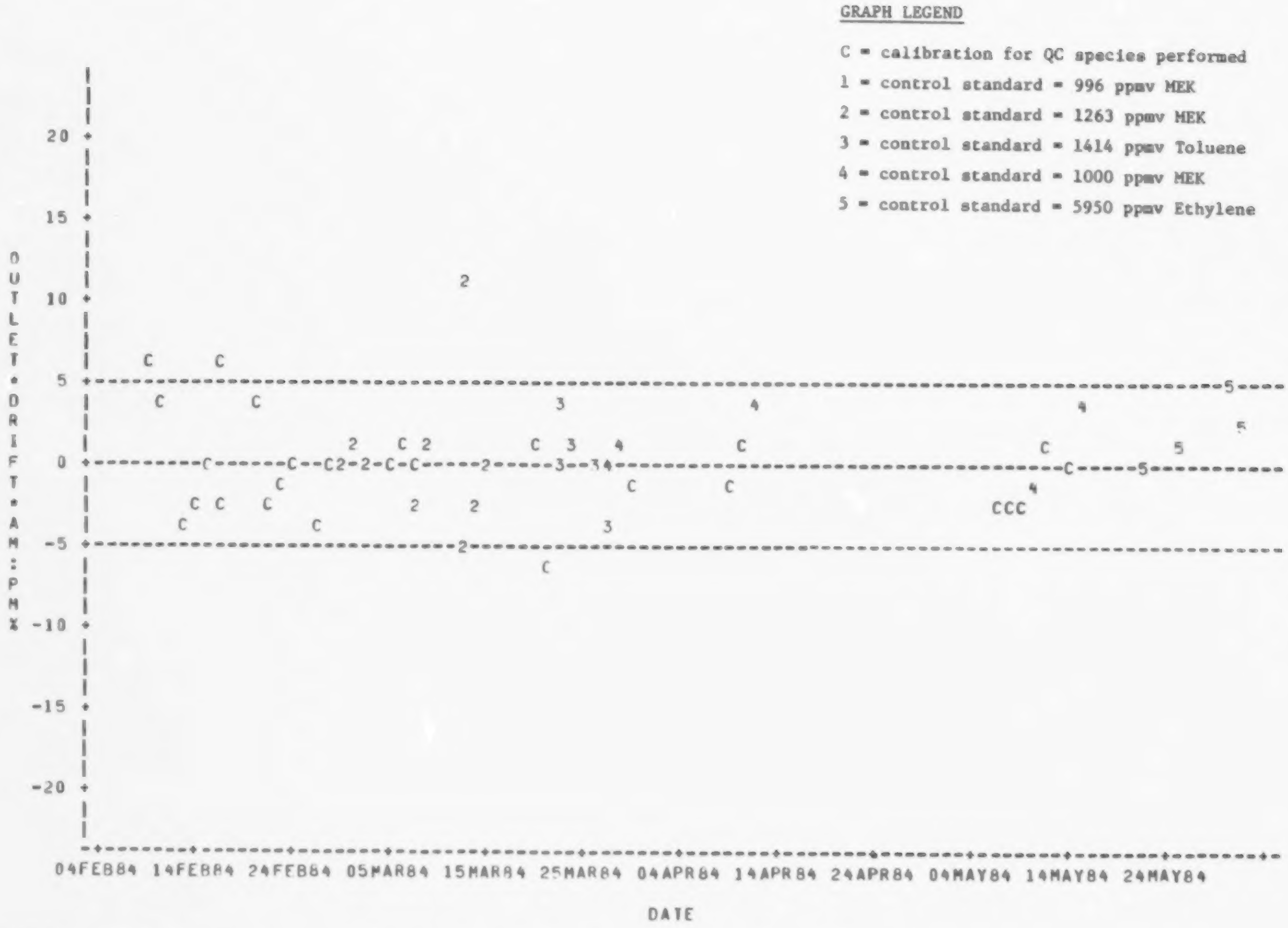
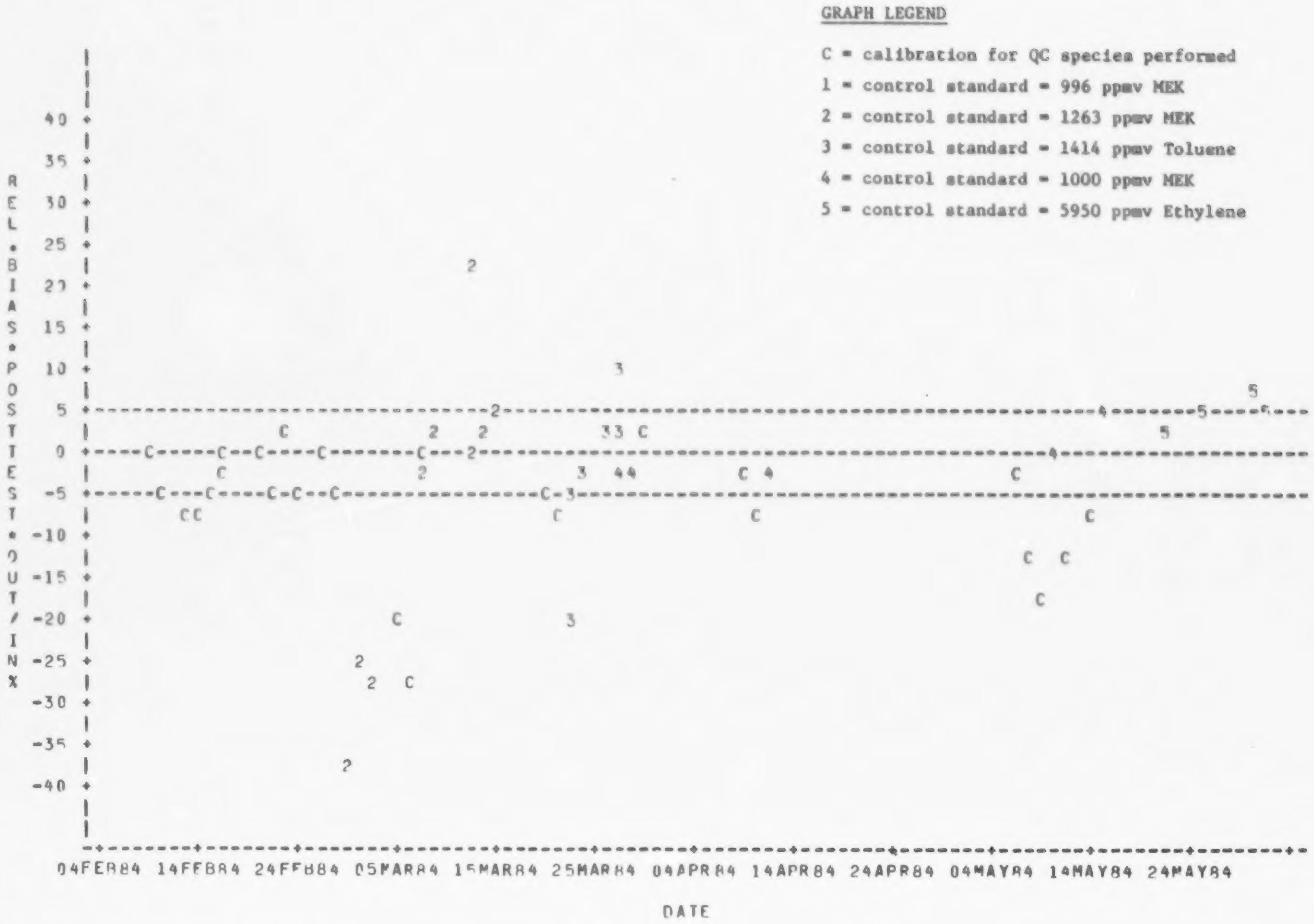


Figure C-4. Method 18--Inlet Drift Data.



NOTE: 4 OBS HAD MISSING VALUES OR WERE OUT OF RANGE 1 OBS HIDDEN

Figure C-5. Method 18--Outlet Drift Data.



NOTE: 4 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

Figure C-6. Method 18--Posttest Relative Bias Data.

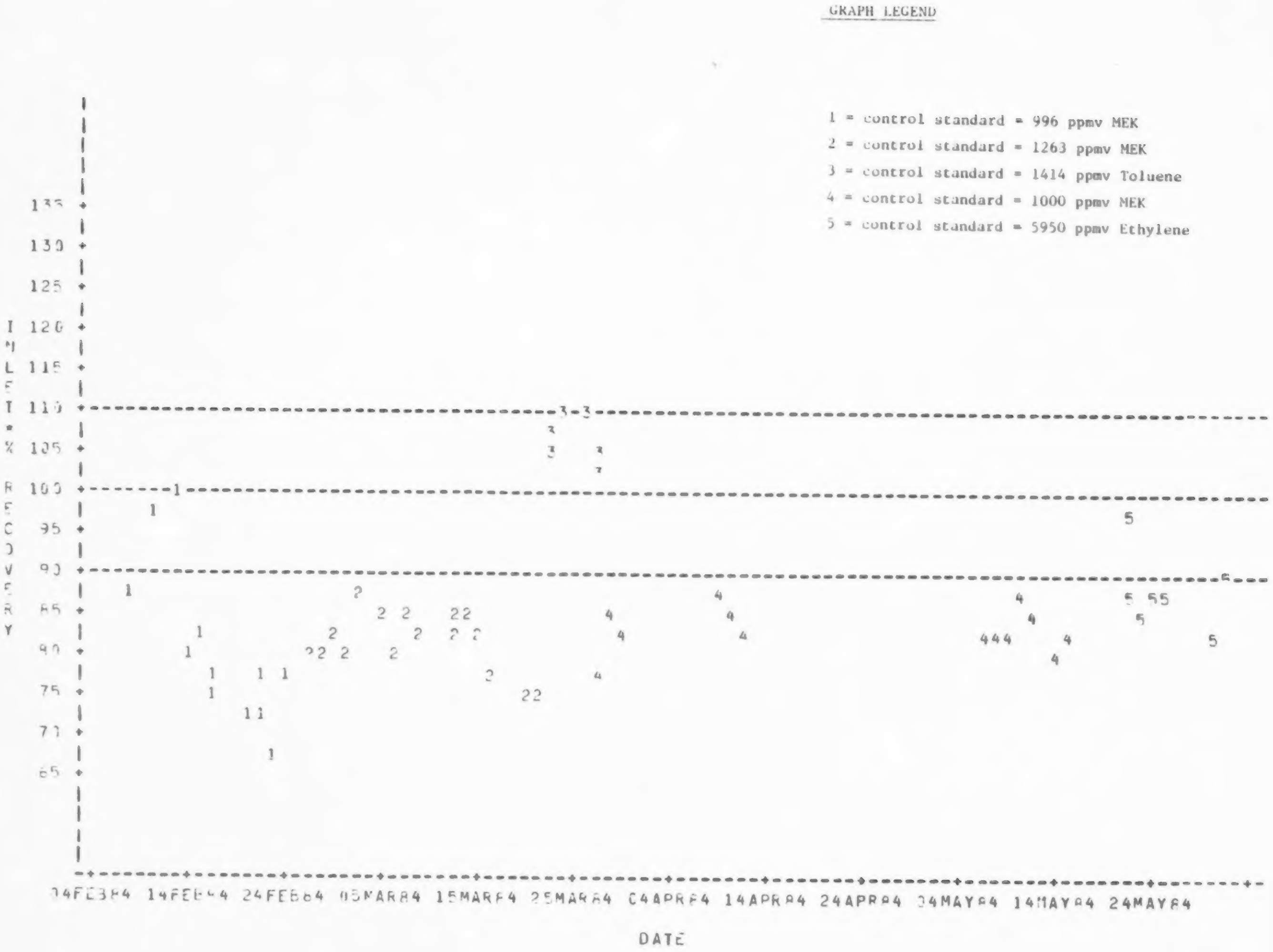


Figure C-7. Method 25A--Pretest Inlet QC Data.

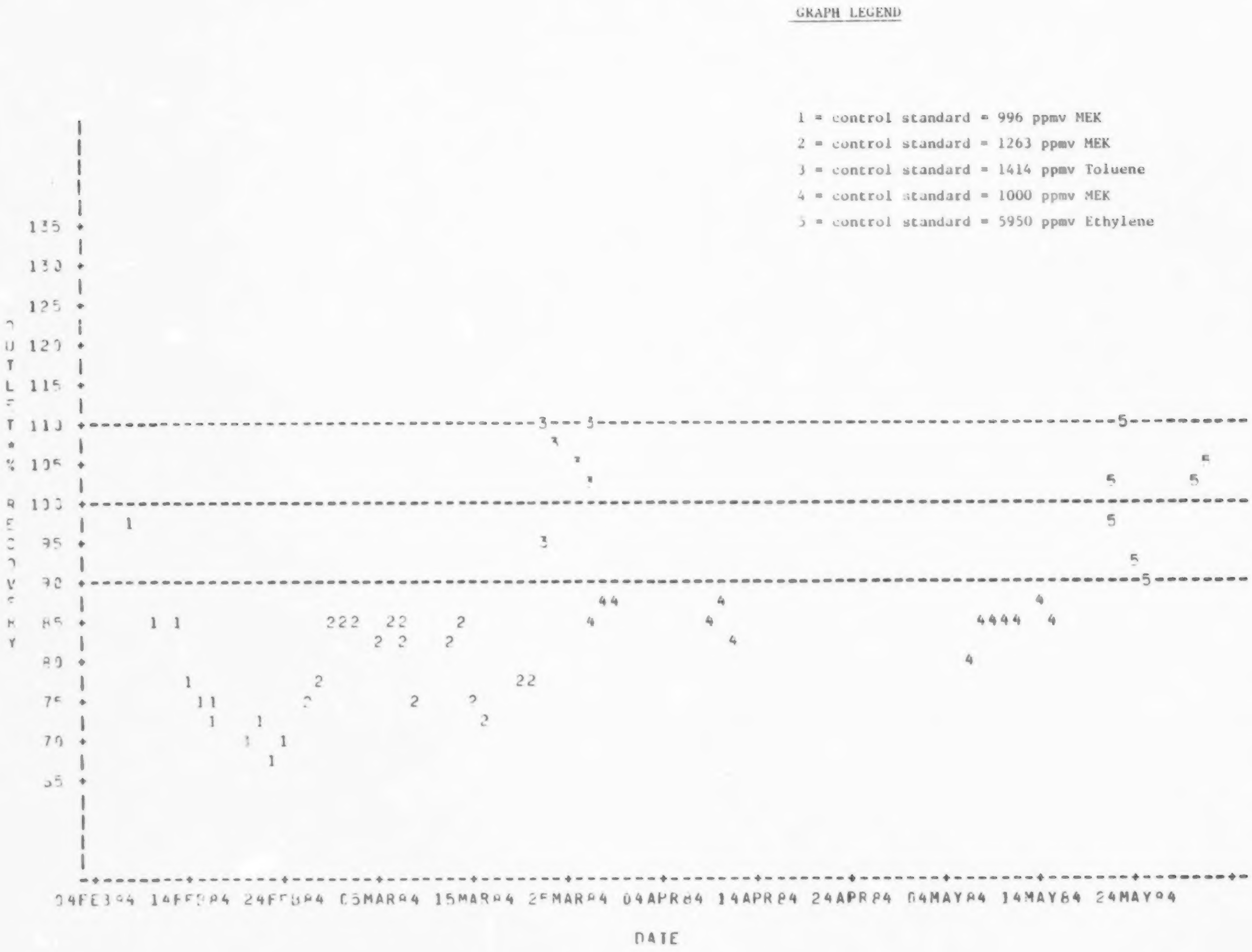


Figure C-8. Method 25A--Pretest Outlet QC Data.

variability (in terms of the CV) for the inlet system was 7.4% for control standards containing MEK, 4.4% for those containing toluene, and 1.5% for those containing ethylene. For the same control sample analyses at the outlet instruments, the CVs were 7.2%, 5.5%, and 6.9%, respectively.

Relative bias between inlet and outlet Method 25A systems ranged from -17.0% to 23.8% with a mean of 0.7% based on pretest control sample analyses. These data are presented in Figure C-9. As for Method 18, the control standard was also analyzed at the conclusion of each day's testing. Relative bias calculated using these data ranged from -9.2% to 24.0% with a mean of 2.9%. These data are plotted in Figure C-10. As with Method 18 data, the relative bias between inlet and outlet instruments is an important consideration when determining destruction efficiency and should be taken into consideration when assessing the reliability of destruction efficiency measurements.

Within-day drift for the Method 25A system at the incinerator inlet ranged from -11.0% to 15.8% with a mean drift of -1.6%. Outlet drift ranged from -4.1% to 10.1% with a mean of 1.0%. These data are presented in Figures C-11 and C-12. The ±5% control limits for drift were exceeded five times for the inlet system and ten times (a frequency of approximately 18%) for the outlet system.

C.4.3 Carbon Monoxide QC Data

Day-to-day variability for the carbon monoxide (CO) instrument was determined by daily analyses of a carbon monoxide control standard prior to testing. Data for these analyses are plotted in terms of relative error in Figure C-13. The acceptance criterion for the pretest control check was agreement of the measured value within ±5% of the "actual" control standard concentration. Although over 50% of the checks exceeded this criterion, all except one was within ±10% of the actual concentration. For the 50 ppm control standard used, a 5% error represents only 2.5 ppm. Day-to-day

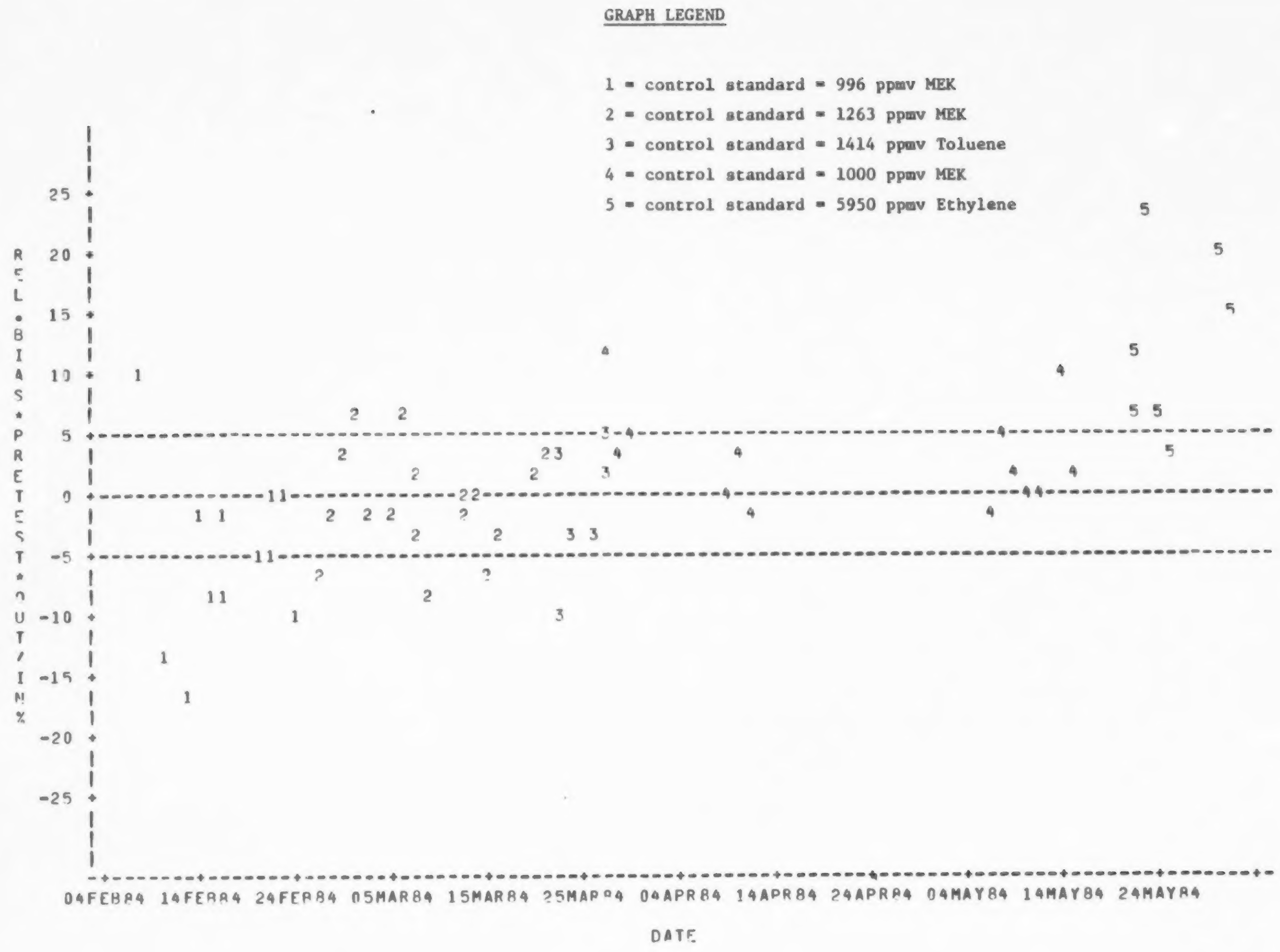
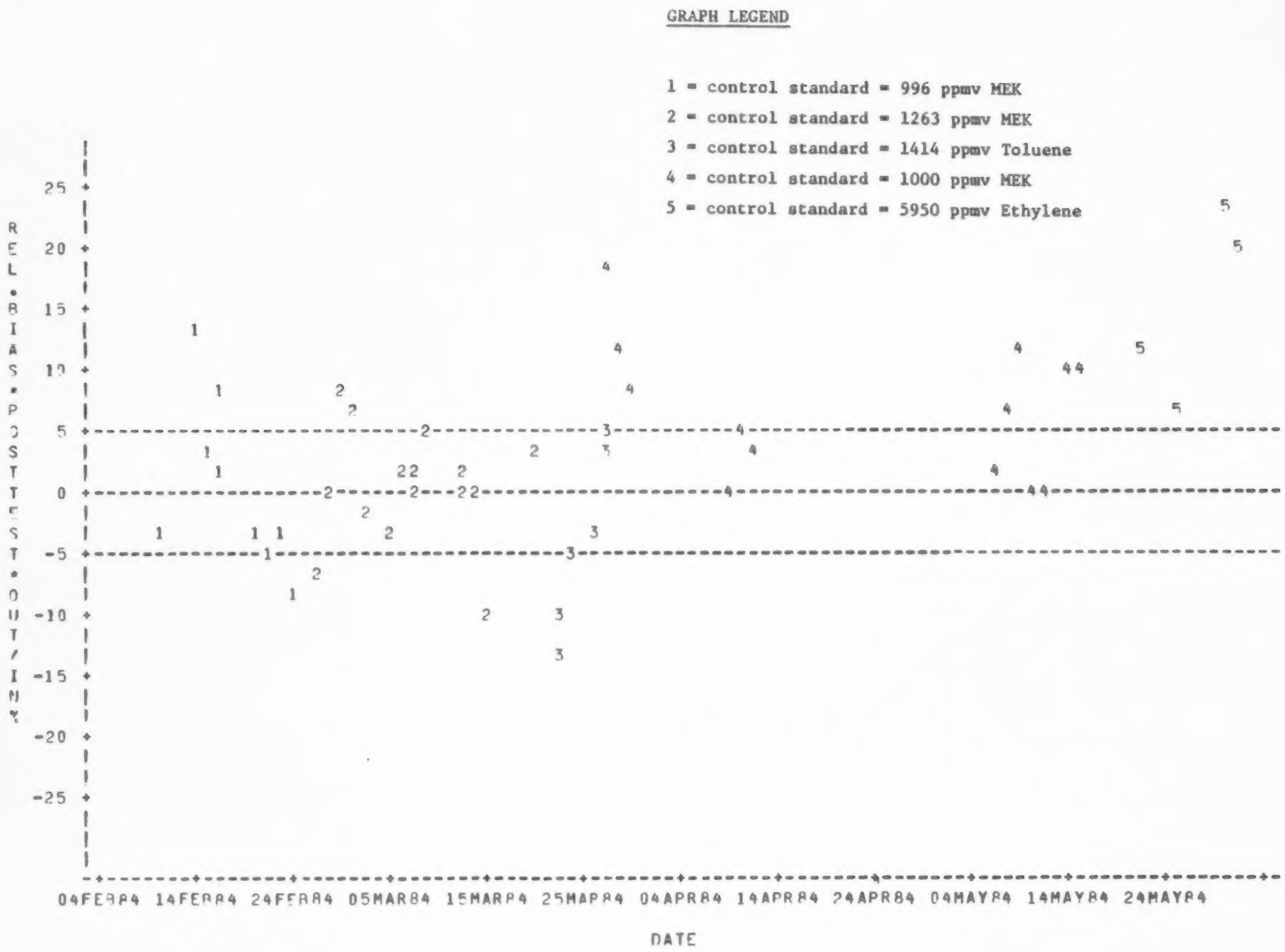


Figure C-9. Method 25A--Pretest Relative Bias Data.



NOTE: 8 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

Figure C-10. Method 25A--Posttest Relative Bias Data.

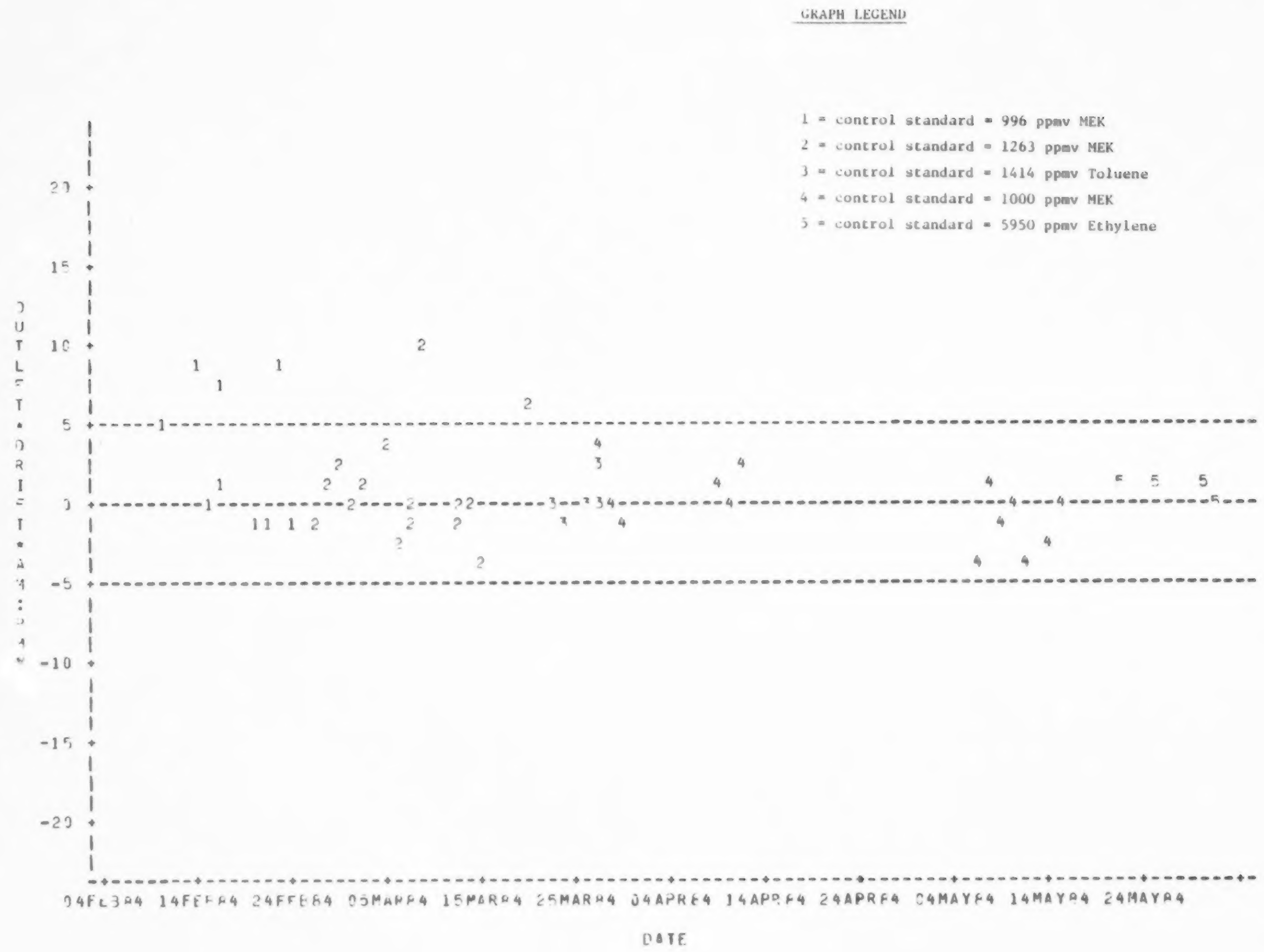


Figure C-11. Method 25A--Outlet Drift Data.

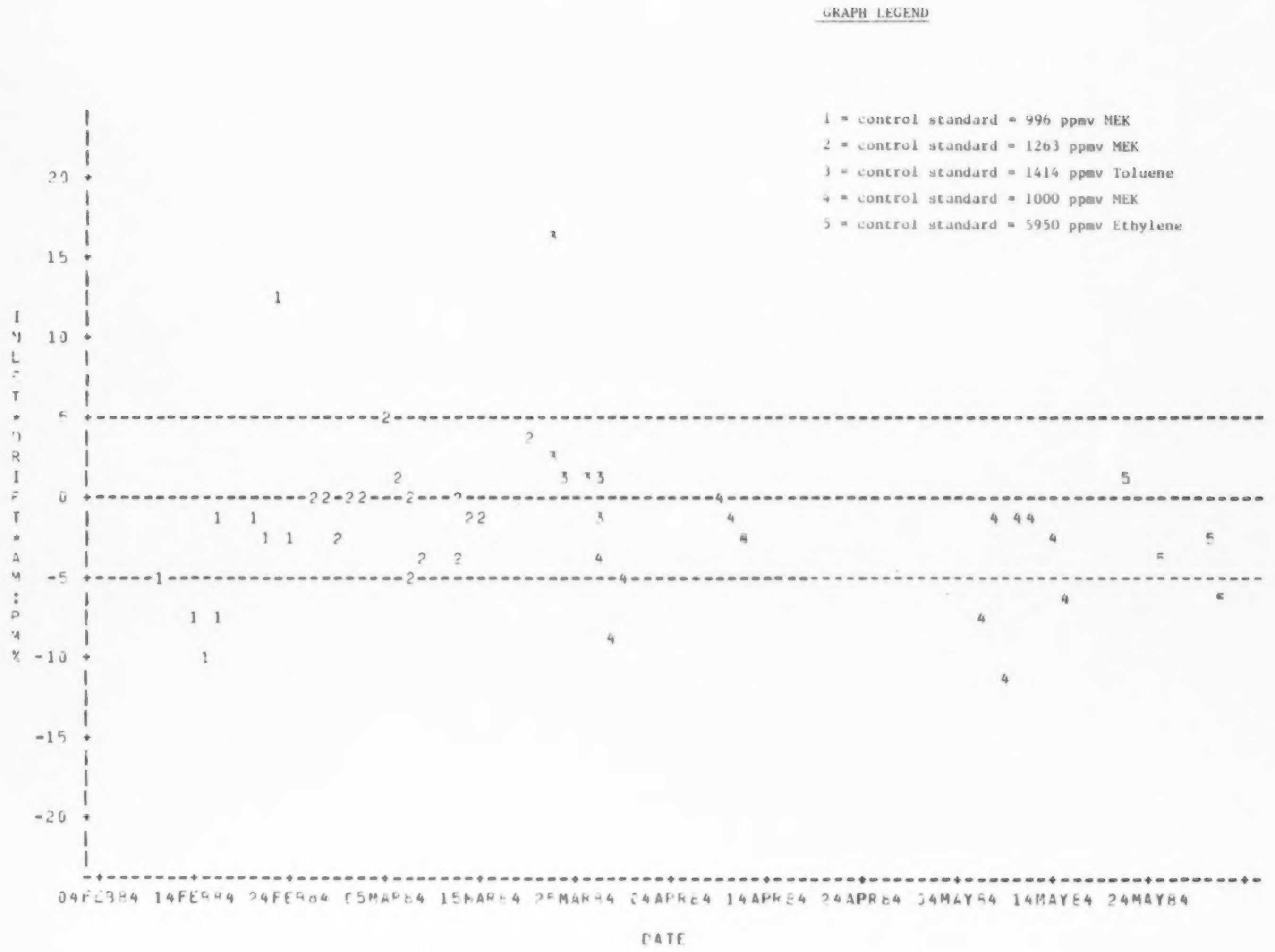


Figure C-12. Method 25A--Inlet Drift Data.

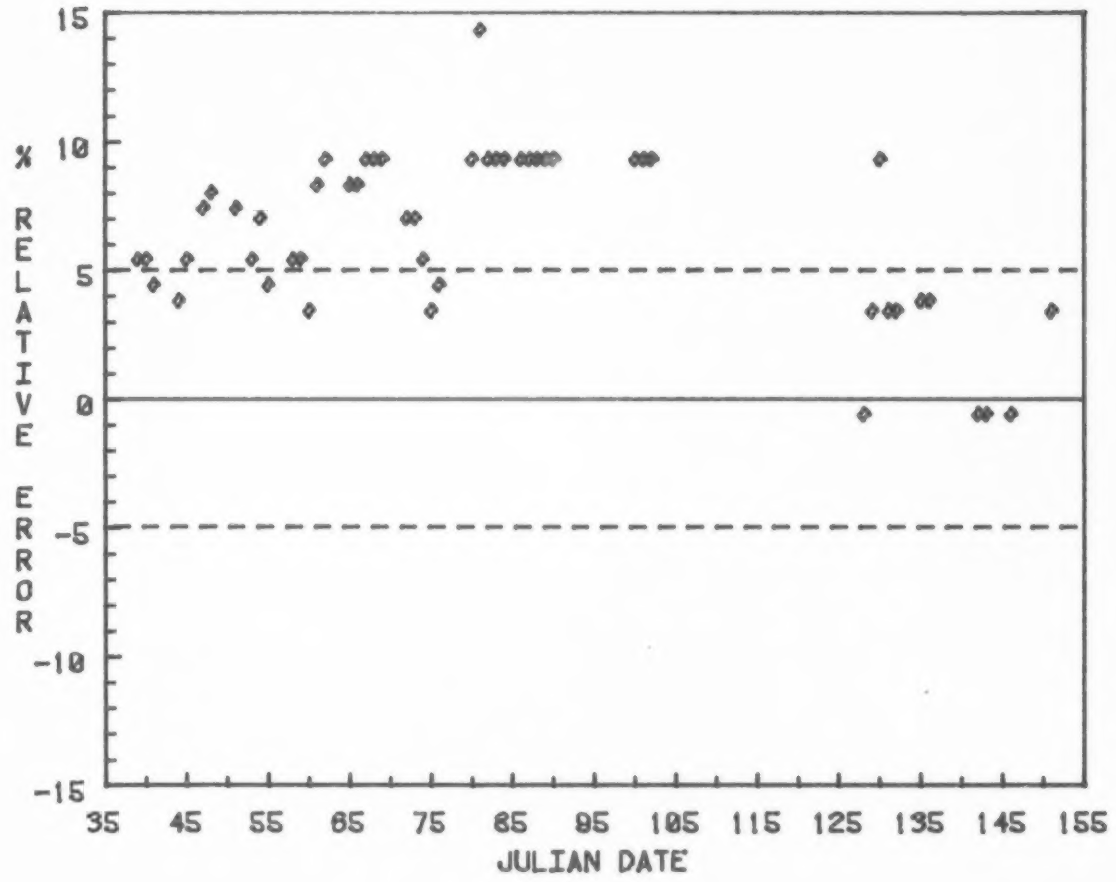


Figure C-13. CO Pretest QC Data (February 9, 1984 to May 31, 1984).

variability for the control standard analyses was 3.0%, expressed as the coefficient of variation.

At the conclusion of each day's testing, the control standard was analyzed again to determine within-day response drift. For this check, the relative difference between the pretest and posttest responses was to be within ±5%. These drift data are presented in Figure C-14. Mean drift for the CO analyzer was -0.8% with a standard deviation of 2.1%. Only five instances were noted where drift exceeded the ±5% control limits.

C.4.4 Fixed Gas QC Data

Analysis of a control standard composed of 2.01% carbon dioxide (CO_2), 9.96% oxygen (O_2), and 88.03% nitrogen (N_2) was used to track variability and drift for the Fisher Gas Partitioner. This instrument was used for fixed gas analyses and was in operation only during the last ten days of testing (i.e., during ethylene oxide testing). Control standard analysis data are presented in Table C-12. All instrument response and error values are presented as absolute percent by volume. The mean pretest response errors ranged from -0.07% to 0.04% with a mean of 0.015% for CO_2, -1.52% to -0.96% with a mean of -1.2% for O_2, and -1.03% to 2.47% with a mean of 0.79% for N_2.

As for the other methods, the control standard was also analyzed at the end of testing each day to determine drift. For posttest control standard analyses, the mean response error was 0.093% for CO_2, -0.77% for O_2, and 4.2% for N_2. The mean pretest to posttest instrument drift for CO_2 ranged from -0.08% to 0.27% with a mean of 0.09%. Within-day drift for O_2 ranged from 0.05% to 1.06% with a mean of 0.54%. N_2 response exhibited a mean within-day drift of 4.7% ranging from -3.0% to 10.30%. Ultimately, however, the N_2 data collected using the Fisher analyzer were discarded due to the problems with unacceptably high drift. Reported N_2 values were calculated by difference from the O_2 and CO_2 data.

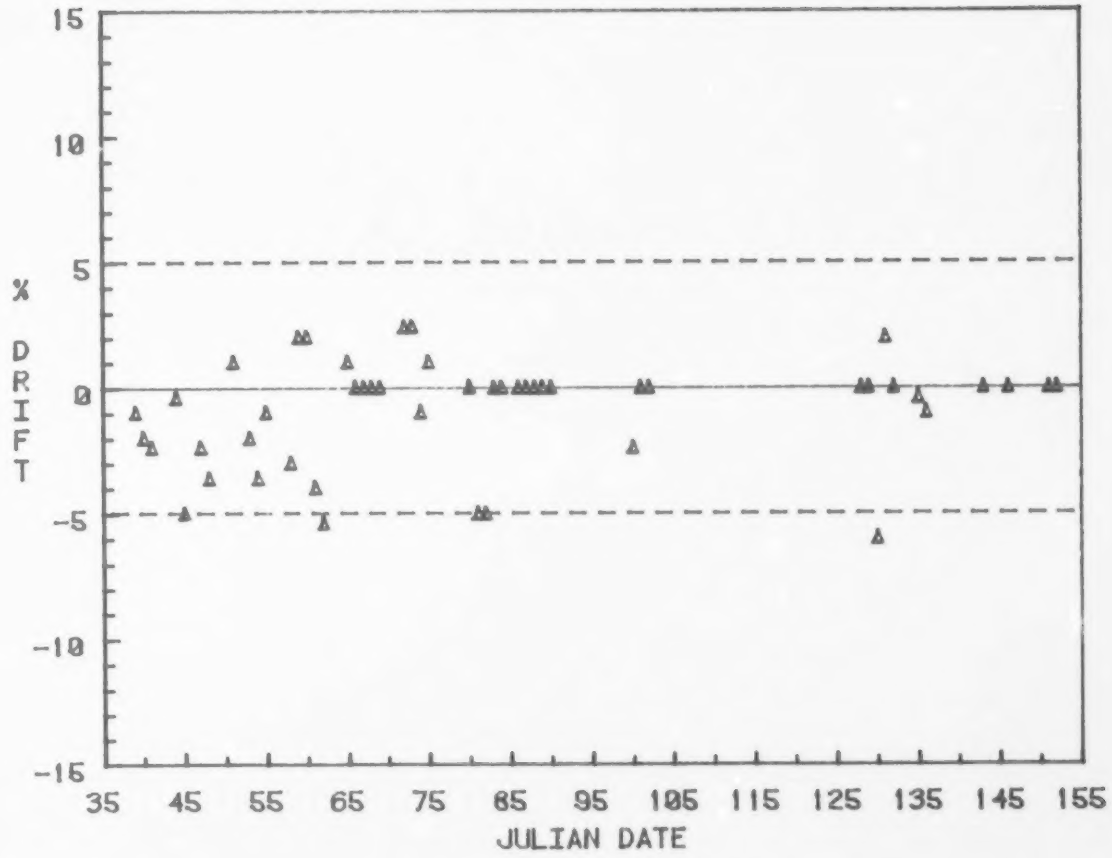


Figure C-14. CO Drift Data (February 9, 1984 to May 31, 1984).

TABLE C-12. FISHER CONTROL STANDARD DATA

Date	Component	Pretest Response (%)	Error (%)	Posttest Response (%)	Error (%)	Drift (%)
052284	CO_2	1.94	-0.07	1.86	-0.15	-0.08
	O_2	8.83	-1.13	8.88	-1.08	0.05
	N_2	88.7	0.67	85.7	-2.33	-3.00
052384	CO_2	2.04	0.03			
	O_2	8.95	-1.01			
	N_2	90.5	2.47			
052484	CO_2	2.05	0.04			
	O_2	9.00	-0.96			
	N_2	87.9	-0.13			
052584	CO_2	2.02	0.01	2.00	-0.01	-0.02
	O_2	8.44	-1.52	8.58	-1.38	0.14
	N_2	84.9	1.37	89.4	1.37	4.50
053084	CO_2	2.05	0.04	2.32	0.31	0.27
	O_2	8.71	-1.25	9.77	-0.19	1.06
	N_2	89.4	1.37	99.7	11.67	10.30
053184	CO_2	2.05	0.04	2.23	0.22	0.18
	O_2	8.63	-1.33	9.52	-0.44	0.89
	N_2	87.0	-1.03	94.1	6.07	7.10

QC Gas Concentration = 2.01% CO_2, 9.96% O_2, and 88.03% N_2

APPENDIX D

CATALYST OPERATING LIFE DATA

TABLE D-1. OPERATING LIFE OF CATALYST APPLIED IN VARIOUS INDUSTRIES[a]

Industry or Application	Typical Minimum Operating Life	Frequency of Cleaning
Formaldehyde	5 Years	None specified
Can Coating	5 to 6 Years	Once per year
Automotive Painting	5 Years	Once per year
Metal Coil Coating	3 Years	3 to 4 times per year
Rubber Coating of Steel	7 Years	None specified
Coating/Laminating of Films	6 Years	Once per year or 2 years
Tire Cords	5 Years	Once per year
Acrylonitrile	4 Years	None specified

[a] Source: Collins, M. F., Englehard Corporation. Written communication to B. A. Tichenor, U.S. Environmental Protection Agency. Union, New Jersey, November 5, 1984.

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APPENDIX E

METHOD 25A AND METHOD 18 DATA SUMMARIES

Method 25A and Method 18 analysis results are summarized in this section. All data presented in this section are preliminary, pending a final review of the data. Method 25A results are presented in Section E.1 and Method 18 results are presented in Section E.2.

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E.1 METHOD 25A DATA SUMMARY

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SUMMARY OF BYRON 301 DATA

TEST NUMBER	AVERAGE MEASURED INLET CONC (PPMV-C)	AVERAGE MEASURED OUTLET CONC (PPMV-C)	DESTRUCTION EFFICIENCY (%)	
			MEAN	(95% C.I.)
A-1	6030	775	87.13	(86.2, 87.87)
A-2	1445	118	91.83	(91.3, 92.24)
A-4	7846	789	89.94	(89.5, 90.35)
A-5	7846	789	89.94	(89.4, 90.34)
A-7	1229	124	89.88	(88.3, 91.16)
A-8	1161	245	78.94	(77.9, 79.92)
A-10	7059	706	90.00	(89.7, 90.25)
A-11	1118	132	88.17	(87.6, 88.69)
A-12	1496	138	90.77	(90.2, 91.20)
A-13	5941	930	84.30	(82.9, 85.60)
A-18	5340	402	92.50	(91.8, 93.10)
A-19	1069	43	95.96	(95.7, 96.22)
A-20	1010	43	95.76	(95.5, 95.95)
A-21	6940	529	92.39	(91.7, 92.95)
A-22	4290	203	95.28	(94.7, 95.85)
A-23	6023	360	94.00	(93.5, 94.44)
A-24	1256	85	93.22	(92.9, 93.53)
A-25	1079	136	87.42	(86.8, 87.91)
A-26	5812	617	89.38	(88.8, 89.94)
A-27	5448	323	94.06	(93.7, 94.39)
A-28	5237	62	98.81	(98.6, 98.98)
A-29	1429	255	82.17	(81.7, 82.58)
A-30	6130	1004	83.63	(82.8, 84.43)
A-31	4981	366	92.65	(92.0, 93.24)
A-32	5164	318	93.83	(93.4, 94.28)
A-33	1223	81	93.34	(92.9, 93.68)
A-34	1374	338	75.44	(74.7, 76.20)
A-35	5817	1234	78.77	(77.9, 79.49)
A-36	4668	643	86.26	(85.3, 87.19)
A-37	1388	78	94.39	(94.2, 94.55)
A-38	4666	549	88.24	(87.9, 88.54)
A-39	5888	317	94.63	(94.4, 94.78)
A-44	6235	746	88.05	(87.0, 89.08)
B-1	4881	697	85.76	(84.8, 86.60)
B-2	973	215	77.97	(76.9, 79.07)
B-3	4822	527	89.08	(88.3, 89.67)
B-4	4749	343	92.79	(92.3, 93.23)
B-5	951	247	74.06	(73.0, 75.12)
B-6	985	96	90.23	(89.8, 90.64)
B-7	4840	272	94.35	(93.6, 95.01)
B-9	1117	141	87.36	(86.8, 87.86)
B-10	5378	539	89.97	(89.6, 90.32)
B-11	5206	723	86.14	(85.1, 86.95)
B-12	5378	172	96.80	(96.6, 96.94)
B-13	1127	193	82.85	(75.4, 89.48)

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SUMMARY OF BYRON 301 DATA

TEST NUMBER	AVERAGE MEASURED INLET CONC (PPMV-C)	AVERAGE MEASURED OUTLET CONC (PPMV-C)	DESTRUCTION EFFICIENCY (%)	
			MEAN	(95% C.I.)
B-14	5245	540	89.70	(88.8, 90.56)
B-15	1043	39	96.31	(96.1, 96.46)
B-16	5167	319	93.83	(93.5, 94.14)
B-17	1111	73	93.40	(93.1, 93.65)
C-1	9577	634	93.38	(93.2, 93.54)
C-2	9706	565	94.17	(93.9, 94.38)
C-3	9380	408	95.64	(95.3, 95.88)
C-4	1084	150	86.13	(85.6, 86.60)
C-5	1014	3	99.72	(99.7, 99.73)
C-6	1042	10	99.05	(98.9, 99.12)
C-7	1022	35	96.61	(96.4, 96.74)
C-8	1055	62	94.08	(93.6, 94.49)
C-9	1021	30	97.10	(96.9, 97.22)
C-10	1049	118	88.75	(88.2, 89.29)
C-12	1065	76	92.84	(92.7, 92.97)
C-13	984	96	90.30	(89.8, 90.69)
C-14	974	55	94.40	(94.2, 94.52)
C-15	987	14	98.62	(98.5, 98.66)
C-16	975	30	96.93	(96.8, 97.04)
C-17	1006	3	99.72	(99.7, 99.73)
C-18	980	36	96.33	(96.2, 96.43)
C-19	1050	77	92.70	(92.5, 92.87)
C-20	696	43	93.78	(93.6, 93.95)
C-21	1145	155	86.47	(85.9, 87.06)
C-22	857	6	99.28	(99.1, 99.38)
C-23	862	12	98.57	(98.5, 98.61)
C-24	908	37	95.91	(95.6, 96.19)
C-25	915	53	94.23	(93.8, 94.57)
C-26	879	40	95.50	(95.3, 95.66)
C-27	893	62	93.08	(92.7, 93.39)
C-28	785	49	93.82	(93.3, 94.28)
C-29	936	5	99.42	(99.3, 99.45)
C-30	918	17	98.15	(98.0, 98.25)
C-31	926	57	93.81	(93.4, 94.12)
C-32	1281	11	99.17	(99.0, 99.26)
C-33	1313	56	95.75	(95.6, 95.90)
C-34	1308	28	97.84	(97.7, 97.98)
C-35	1263	65	94.87	(94.6, 95.07)
C-36	1255	49	96.07	(95.9, 96.23)
C-37	1225	151	87.64	(87.2, 87.92)
C-38	1261	93	92.60	(92.2, 92.92)
C-39	1296	193	85.12	(84.3, 85.90)
C-40	1218	151	87.62	(87.0, 88.18)
C-41	1246	154	87.60	(86.5, 88.65)
C-42		25		

SUMMARY OF BYRON 301 DATA

TEST NUMBER	AVERAGE MEASURED INLET CONC (PPMV-C)	AVERAGE MEASURED OUTLET CONC (PPMV-C)	DESTRUCTION EFFICIENCY (%)	
			MEAN	(95% C.I.)
C-43	1117	58	94.75	(94.3, 95.13)
C-43H	1129	757	32.93	(28.2, 37.48)
C-44	1044	7	99.30	(99.2, 99.35)
C-44H	1084	287	73.50	(71.9, 75.00)
C-45	1123	44	96.07	(95.9, 96.24)
C-45H	1074	677	36.77	(31.6, 41.10)
C-46	1070	77	92.75	(91.0, 94.23)
C-46H	1078	757	29.81	(26.5, 33.24)
C-47	1173			
C-47H	1030	547	46.82	(38.5, 53.34)
C-48	1030	62	93.94	(93.7, 94.27)
C-48H	1023	609	40.40	(36.4, 44.00)
C-49	1010	140	86.11	(84.9, 87.14)
C-49H	1023	791	22.72	(19.9, 25.81)
C-50	1021	90	91.15	(90.6, 91.62)
C-50H	1048	668	36.17	(33.3, 38.99)
C-51	998	110	89.00	(88.6, 89.32)
C-51H	953	784	17.76	(14.7, 20.60)
C-52	951	38	96.01	(95.6, 96.34)
C-52H	1015	547	45.99	(42.9, 48.45)
C-53	1032	11	98.98	(98.9, 99.03)
C-53H	1021	299	70.70	(68.6, 72.63)
C-54	1017	36	96.42	(96.1, 96.64)
C-54H	988	487	50.63	(47.6, 53.69)
C-55	1279	142	88.86	(88.2, 89.47)
C-55H	1276	984	22.91	(20.0, 25.71)
C-56	1293	76	94.15	(93.9, 94.31)
C-56H	1325	932	29.70	(27.6, 31.80)
C-57	1310	24	98.13	(97.9, 98.33)
C-57H	1280	764	40.37	(38.6, 42.11)
C-58	1276	120	90.60	(90.2, 90.91)
C-59	1276	91	92.83	(92.6, 93.00)
C-59H	1486	928	37.51	(34.9, 40.03)
C-60	752	52	93.12	(92.7, 93.51)
C-60H	759	558	26.30	(22.4, 29.78)
C-61	730	7	98.99	(98.8, 99.10)
C-61H	786	235	70.18	(68.8, 71.58)
C-62	744	23	96.95	(96.7, 97.17)
C-62H	787	356	54.88	(52.6, 56.91)
C-63	928	104	88.82	(88.4, 89.23)
C-63H	924	727	21.36	(19.2, 23.52)
C-64	920	14	98.45	(98.3, 98.53)
C-64H	944	319	66.20	(64.7, 67.62)
C-65	1014	50	95.06	(94.9, 95.24)
C-65H	931	465	49.88	(44.4, 55.41)
C-66	668	11	98.38	(98.2, 98.50)

SUMMARY OF BYRON 301 DATA

TEST NUMBER	AVERAGE MEASURED INLET CONC (PPMV-C)	AVERAGE MEASURED OUTLET CONC (PPMV-C)	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) (95% C.I.)
C-66H	620	367	40.70	(37.8, 43.74)
C-67	650	17	97.39	(97.3, 97.44)
C-67H	652	476	27.06	(25.1, 28.96)
C-68	644	6	98.99	(98.9, 99.06)
C-69	659	17	97.45	(97.3, 97.54)
C-70	1227	261	78.80	(77.0, 80.54)
C-70H	1253	705	43.65	(39.6, 47.07)
C-71	1193	796	33.21	(31.0, 35.34)
C-71H	1173	951	18.70	(13.9, 22.94)
C-72	1182	483	59.00	(55.1, 62.77)
C-73	1177	1210	-2.95	(-18., 9.54)
C-73H	1143	1232	-7.65	(-15., -0.19)
C-74	1138	909	20.35	(16.4, 23.98)
C-75	1227	1229	0.09	(-7.3, 6.82)
C-76	1426	1109	22.15	(18.8, 25.37)
C-76H	1418	1414	0.28	(-2.4, 2.54)
C-79	1044	302	71.08	(70.1, 71.94)
C-80	1043	110	89.45	(88.3, 90.66)
D-1	1064	76	92.84	(91.8, 93.71)
D-2	1057	20	98.09	(98.0, 98.18)
D-3	1033	41	96.05	(95.7, 96.35)
D-3H	1072	628	41.39	(37.8, 44.45)
D-4	1030	126	87.78	(87.1, 88.37)
D-4H	976	861	11.59	(6.3, 17.11)
D-5	1023	62	93.94	(93.6, 94.20)
D-5H	1005	720	28.42	(26.6, 30.28)
D-6	1174	69	94.15	(93.9, 94.33)
D-7	1193	37	96.87	(96.7, 96.99)
D-7H	1149	806	29.87	(24.9, 35.12)
D-8	1141	23	97.96	(97.8, 98.02)
D-9	1137	53	95.37	(95.2, 95.50)
D-9H	1108	811	26.66	(21.2, 32.13)
E-1	956	76	92.01	(91.7, 92.26)
E-1C	861	76	91.12	(90.7, 91.54)
E-2	980	22	97.70	(97.5, 97.89)
E-2C	686	22	96.82	(96.6, 96.99)
E-3	1076	46	95.77	(95.5, 95.97)
E-3C	838	44	94.71	(94.4, 94.98)
E-4	1000	14	98.62	(98.5, 98.71)
E-4C	587	14	97.65	(97.5, 97.79)
E-5	1000	24	97.61	(97.4, 97.77)
E-5C	706	24	96.57	(96.4, 96.73)
E-6	1043	17	98.40	(98.2, 98.58)
E-6C	583	13	97.75	(97.6, 97.85)

SUMMARY OF BYRON 301 DATA

TEST NUMBER	AVERAGE MEASURED INLET CONC (PPMV-C)	AVERAGE MEASURED OUTLET CONC (PPMV-C)	DESTRUCTION EFFICIENCY (%)	
			MEAN	(95% C.I.)
E-7C	550	10	98.18	(98.1, 98.26)
E-8	951	36	96.18	(95.9, 96.37)
E-8C	772	35	95.44	(95.2, 95.65)
E-9C	327	4	98.67	(98.5, 98.77)
E-10	973	3	99.68	(99.6, 99.70)
E-10C	369	3	99.27	(99.2, 99.30)
E-11	910	3	99.64	(99.6, 99.66)
E-11-R	909	3	99.64	(99.6, 99.66)
E-11C	270	3	98.80	(98.6, 98.91)
E-12	1063	30	97.20	(97.1, 97.30)
E-12C	851	28	96.72	(96.5, 96.86)
E-13C	319	8	97.54	(97.4, 97.61)
E-14	836	8	99.04	(98.9, 99.11)
E-14C	349	7	98.00	(97.9, 98.08)
E-15	867	7	99.21	(99.1, 99.29)
E-15C	335	7	97.97	(97.9, 98.03)
E-16C	742	18	97.60	(97.5, 97.69)
E-17	1103	13	98.86	(98.8, 98.90)
E-17C	781	12	98.45	(98.4, 98.48)
E-18	1098	13	98.82	(98.7, 98.86)
E-19C	728	27	96.30	(96.0, 96.56)
F-1	7981	173	97.83	
F-1C	7842	179	97.72	
F-2C	7721	20	99.74	(99.7, 99.77)
F-3	7610	10	99.87	
F-3C	7419	7	99.91	
F-4	7127	221	96.90	
G-1	7623	72	99.06	
G-1C	7302	73	99.00	
G-2C	7399	182	97.54	
G-3	8595	408	95.25	
G-4	12E3	126	98.93	

E.2 METHOD 18 DATA SUMMARY

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RUN #    A-1        CATALYST INLET TEMP (DEG F)        580          SPACE VELOCITY                          49,772
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)       746          RESIDENCE TIME (SECONDS)                 0.022
                    CATALYST BED TEMP RISE (DEG F)     166          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                           AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                           CALCULATED    CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                                    INLET CONC    ----------------------             STD.        95% C.I.
 CODE      SPECIES                          (PPMV-C)        INLET     OUTLET        MEAN     DEV.     ON THE MEAN
------------------------------------------------------------------------------------------------------------------

   1      ISOPROPANOL                         1174          1092      110.4         89.90    0.139    ( 89.76, 90.04)
   2      METHYL ETHYL KETONE                 1170          1109      106.5         90.40    0.159    ( 90.24, 90.56)
   3      ETHYL ACETATE                       1172          1088      130.6         88.00    0.140    ( 87.86, 88.15)
   4      BENZENE                             1178          1068       97.2         90.90    0.065    ( 90.83, 90.97)
   5      N-HEXANE                            1166          1049      195.2         81.39    0.105    ( 81.29, 81.50)

  99      TOTAL HC                            5860          5408      640.0         88.17    0.109    ( 88.06, 88.28)


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RUN #    A-2        CATALYST INLET TEMP (DEG F)        714          SPACE VELOCITY                          49,967
MIXTURE             CATALYST OUTLET TEMP (DEG F)       741          RESIDENCE TIME (SECONDS)                 0.021
                    CATALYST BED TEMP RISE (DEG F)      27          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                           AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                           CALCULATED    CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                                    INLET CONC    ----------------------             STD.        95% C.I.
 CODE      SPECIES                          (PPMV-C)        INLET     OUTLET        MEAN     DEV.     ON THE MEAN
------------------------------------------------------------------------------------------------------------------

   5      N-HEXANE                            1183          1103       77.3         92.99    0.157    ( 92.85, 93.14)


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RUN #    A-3        CATALYST INLET TEMP (DEG F)         581          SPACE VELOCITY                         49,870
MIXTURE             CATALYST OUTLET TEMP (DEG F)        647          RESIDENCE TIME (SECONDS)                0.023
                    CATALYST BED TEMP RISE (DEG F)       66          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                   AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                    CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
 SPECIES                            INLET CONC   ----------------------               STD.        95% C.I.
  CODE        SPECIES                (PPMV-C)      INLET      OUTLET       MEAN       DEV.      ON THE MEAN
----------------------------------------------------------------------------------------------------------------
   1       ISOPROPANOL                 1210         1228       153.7       87.49      0.110    ( 87.39, 87.59)


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RUN #    A-4        CATALYST INLET TEMP (DEG F)         578          SPACE VELOCITY                         49,870
MIXTURE             CATALYST OUTLET TEMP (DEG F)        750          RESIDENCE TIME (SECONDS)                0.022
                    CATALYST BED TEMP RISE (DEG F)      172          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                   AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                    CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
 SPECIES                            INLET CONC   ----------------------               STD.        95% C.I.
  CODE        SPECIES                (PPMV-C)      INLET      OUTLET       MEAN       DEV.      ON THE MEAN
----------------------------------------------------------------------------------------------------------------
   4       BENZENE                     6224         5350       475.7       91.11      0.139    ( 90.98, 91.24)


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RUN #    A-5       CATALYST INLET TEMP (DEG F)        584          SPACE VELOCITY                      49,772
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)       749          RESIDENCE TIME (SECONDS)             0.022
                   CATALYST BED TEMP RISE (DEG F)     165          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   -----------------------------------
SPECIES                               INLET CONC   ----------------------               STD.        95% C.I.
 CODE         SPECIES                  (PPMV-C)      INLET      OUTLET        MEAN      DEV.      ON THE MEAN
---------------------------------------------------------------------------------------------------------------

   1       ISOPROPANOL                   1205        1145       110.0         90.40     0.112    ( 90.28, 90.51)
   2       METHYL ETHYL KETONE           1201        1162       104.3         91.02     0.137    ( 90.88, 91.17)
   3       ETHYL ACETATE                 1203        1139       129.3         88.65     0.107    ( 88.54, 88.76)
   4       BENZENE                       1209        1121        97.9         91.26     0.097    ( 91.16, 91.37)
   5       N-HEXANE                      1197        1094       199.8         81.74     0.155    ( 81.58, 81.90)

  99       TOTAL HC                      6015        5663       641.4         88.67     0.114    ( 88.55, 88.79)


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RUN #    A-6       CATALYST INLET TEMP (DEG F)        581          SPACE VELOCITY                      49,870
MIXTURE            CATALYST OUTLET TEMP (DEG F)       645          RESIDENCE TIME (SECONDS)             0.023
                   CATALYST BED TEMP RISE (DEG F)      64          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   -----------------------------------
SPECIES                               INLET CONC   ----------------------               STD.        95% C.I.
 CODE         SPECIES                  (PPMV-C)      INLET      OUTLET        MEAN      DEV.      ON THE MEAN
---------------------------------------------------------------------------------------------------------------

   1       ISOPROPANOL                   1212        1228       150.0         87.79     0.167    ( 87.61, 87.96)


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RUN #    A-7       CATALYST INLET TEMP (DEG F)         581          SPACE VELOCITY                        49,478
MIXTURE            CATALYST OUTLET TEMP (DEG F)        634          RESIDENCE TIME (SECONDS)               0.023
                   CATALYST BED TEMP RISE (DEG F)       53          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                        CALCULATED    CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                 INLET CONC    ----------------------               STD.       95% C.I.
 CODE          SPECIES                  (PPMV-C)       INLET      OUTLET         MEAN      DEV.     ON THE MEAN
-----------------------------------------------------------------------------------------------------------------
  2         METHYL ETHYL KETONE            1167         1212       129.9          89.29    0.070    ( 89.22, 89.35)


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RUN #    A-8       CATALYST INLET TEMP (DEG F)         581          SPACE VELOCITY                        49,674
MIXTURE            CATALYST OUTLET TEMP (DEG F)        630          RESIDENCE TIME (SECONDS)               0.023
                   CATALYST BED TEMP RISE (DEG F)       49          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                        CALCULATED    CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                 INLET CONC    ----------------------               STD.       95% C.I.
 CODE          SPECIES                  (PPMV-C)       INLET      OUTLET         MEAN      DEV.     ON THE MEAN
-----------------------------------------------------------------------------------------------------------------
  3         ETHYL ACETATE                  1188         1209       261.3          78.39    0.138    ( 78.24, 78.53)


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RUN #    A-9       CATALYST INLET TEMP (DEG F)          583          SPACE VELOCITY                        49,870
MIXTURE            CATALYST OUTLET TEMP (DEG F)         642          RESIDENCE TIME (SECONDS)               0.023
                   CATALYST BED TEMP RISE (DEG F)        59          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED         DESTRUCTION EFFICIENCY (%)
                                    CALCULATED    CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                             INLET CONC    ----------------------             STD.      95% C.I.
 CODE      SPECIES                   (PPMV-C)       INLET      OUTLET        MEAN     DEV.    ON THE MEAN
-------------------------------------------------------------------------------------------------------------

  5       N-HEXANE                    1198          1263       114.6        90.93    0.197   ( 90.73, 91.13)

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RUN #    A-10      CATALYST INLET TEMP (DEG F)          581          SPACE VELOCITY                        49,772
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)         745          RESIDENCE TIME (SECONDS)               0.022
                   CATALYST BED TEMP RISE (DEG F)       164          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED         DESTRUCTION EFFICIENCY (%)
                                    CALCULATED    CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                             INLET CONC    ----------------------             STD.      95% C.I.
 CODE      SPECIES                   (PPMV-C)       INLET      OUTLET        MEAN     DEV.    ON THE MEAN
-------------------------------------------------------------------------------------------------------------

  1       ISOPROPANOL                 1227          1237       121.8        90.15    0.068   ( 90.08, 90.22)
  2       METHYL ETHYL KETONE         1223          1253       118.0        90.58    0.075   ( 90.50, 90.66)
  3       ETHYL ACETATE               1225          1244       141.8        88.60    0.082   ( 88.51, 88.69)
  4       BENZENE                     1231          1240       106.2        91.44    0.044   ( 91.40, 91.49)
  5       N-HEXANE                    1228          1241       223.0        82.04    0.129   ( 81.90, 82.17)

 99       TOTAL HC                    6135          6216       710.8        88.57    0.074   ( 88.49, 88.64)

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RUN #    A-11        CATALYST INLET TEMP (DEG F)          581           SPACE VELOCITY                         49,576
MIXTURE              CATALYST OUTLET TEMP (DEG F)         639           RESIDENCE TIME (SECONDS)                0.023
                     CATALYST BED TEMP RISE (DEG F)        58           CATALYST BED PRESS DROP (" H2O)
                     MAIN HEATER TEMPERATURE (DEG F)

                                                           AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                          CALCULATED     CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                   INLET CONC     ----------------------                STD.       95% C.I.
 CODE        SPECIES                      (PPMV-C)         INLET      OUTLET        MEAN       DEV.     ON THE MEAN
--------------------------------------------------------------------------------------------------------------------
   1      ISOPROPANOL                       1208            1275       157.4        87.66     0.036    ( 87.63, 87.68)

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RUN #    A-12        CATALYST INLET TEMP (DEG F)          581           SPACE VELOCITY                         49,576
MIXTURE              CATALYST OUTLET TEMP (DEG F)         635           RESIDENCE TIME (SECONDS)                0.023
                     CATALYST BED TEMP RISE (DEG F)        54           CATALYST BED PRESS DROP (" H2O)
                     MAIN HEATER TEMPERATURE (DEG F)

                                                           AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                          CALCULATED     CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                   INLET CONC     ----------------------                STD.       95% C.I.
 CODE        SPECIES                      (PPMV-C)         INLET      OUTLET        MEAN       DEV.     ON THE MEAN
--------------------------------------------------------------------------------------------------------------------
   5      N-HEXANE                          1207            1239       109.8        91.14     0.125    ( 91.04, 91.23)

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RUN #    A-13       CATALYST INLET TEMP (DEG F)        581           SPACE VELOCITY                        49,870
MIXTURE             CATALYST OUTLET TEMP (DEG F)       722           RESIDENCE TIME (SECONDS)               0.022
                    CATALYST BED TEMP RISE (DEG F)     141           CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                       AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                        CALCULATED   CONCENTRATION (PPMV-C)     ------------------------------------
SPECIES                                 INLET CONC   ----------------------                STD.        95% C.I.
 CODE       SPECIES                     (PPMV-C)        INLET     OUTLET          MEAN      DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------------

   3       ETHYL ACETATE                  6042          5899      1037.4          82.42    0.255    ( 82.20, 82.63)


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RUN #    A-14       CATALYST INLET TEMP (DEG F)        754           SPACE VELOCITY                        49,870
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)       885           RESIDENCE TIME (SECONDS)               0.019
                    CATALYST BED TEMP RISE (DEG F)     131           CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                       AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                        CALCULATED   CONCENTRATION (PPMV-C)     ------------------------------------
SPECIES                                 INLET CONC   ----------------------                STD.        95% C.I.
 CODE       SPECIES                     (PPMV-C)        INLET     OUTLET          MEAN      DEV.      ON THE MEAN
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   1       ISOPROPANOL                    1211          1262        56.7          95.51    0.140    ( 95.36, 95.66)
   2       METHYL ETHYL KETONE            1207          1303        54.0          95.85    0.147    ( 95.70, 96.01)
   3       ETHYL ACETATE                  1210          1283        28.9          97.75    0.478    ( 97.24, 98.25)
   4       BENZENE                        1216          1282        95.8          92.53    0.128    ( 92.39, 92.66)
   5       N-HEXANE                       1203          1322       166.0          87.44    0.664    ( 86.75, 88.14)

  99       TOTAL HC                       6047          6454       401.4          93.78    0.305    ( 93.46, 94.10)


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RUN #    A-15       CATALYST INLET TEMP (DEG F)        748          SPACE VELOCITY                       49,870
MIXTURE             CATALYST OUTLET TEMP (DEG F)       783          RESIDENCE TIME (SECONDS)              0.020
                    CATALYST BED TEMP RISE (DEG F)      35          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                       AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                      CALCULATED     CONCENTRATION (PPMV-C)     -----------------------------------
 SPECIES                               INLET CONC    ----------------------              STD.        95% C.I.
  CODE        SPECIES                  (PPMV-C)       INLET      OUTLET           MEAN    DEV.       ON THE MEAN
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   5        N-HEXANE                     1613          1295        82.5           93.63   0.217    ( 93.40, 93.85)


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RUN #    A-16       CATALYST INLET TEMP (DEG F)        749          SPACE VELOCITY                       49,870
MIXTURE             CATALYST OUTLET TEMP (DEG F)       785          RESIDENCE TIME (SECONDS)              0.020
                    CATALYST BED TEMP RISE (DEG F)      36          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                       AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                      CALCULATED     CONCENTRATION (PPMV-C)     -----------------------------------
 SPECIES                               INLET CONC    ----------------------              STD.        95% C.I.
  CODE        SPECIES                  (PPMV-C)       INLET      OUTLET           MEAN    DEV.       ON THE MEAN
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   1        ISOPROPANOL                  1217          1350        60.6           95.51   0.048    ( 95.47, 95.56)


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RUN #    A-17      CATALYST INLET TEMP (DEG F)          750          SPACE VELOCITY                        49,870
MIXTURE            CATALYST OUTLET TEMP (DEG F)         788          RESIDENCE TIME (SECONDS)               0.020
                   CATALYST BED TEMP RISE (DEG F)        38          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                      AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                        CALCULATED  CONCENTRATION (PPMV-C)   -----------------------------------
SPECIES                                 INLET CONC  ----------------------              STD.       95% C.I.
 CODE       SPECIES                      (PPMV-C)     INLET      OUTLET      MEAN      DEV.     ON THE MEAN
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  4        BENZENE                         1114       1144        91.6       92.00     0.175   ( 91.82, 92.18)


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RUN #    A-18      CATALYST INLET TEMP (DEG F)          750          SPACE VELOCITY                        49,870
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)         883          RESIDENCE TIME (SECONDS)               0.019
                   CATALYST BED TEMP RISE (DEG F)       133          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                      AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                        CALCULATED  CONCENTRATION (PPMV-C)   -----------------------------------
SPECIES                                 INLET CONC  ----------------------              STD.       95% C.I.
 CODE       SPECIES                      (PPMV-C)     INLET      OUTLET      MEAN      DEV.     ON THE MEAN
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  1        ISOPROPANOL                     1241       1346        60.0       95.54     0.067   ( 95.48, 95.60)
  2        METHYL ETHYL KETONE             1236       1353        54.3       95.99     0.064   ( 95.93, 96.05)
  3        ETHYL ACETATE                   1239       1352        36.9       97.27     0.066   ( 97.21, 97.33)
  4        BENZENE                         1245       1336       105.7       92.09     0.121   ( 91.98, 92.20)
  5        N-HEXANE                        1241       1403       187.7       86.62     0.193   ( 86.44, 86.80)

 99        TOTAL HC                        6202       6792       444.6       93.45     0.096   ( 93.36, 93.54)


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RUN #    A-19     CATALYST INLET TEMP (DEG F)           750          SPACE VELOCITY                      49,625
MIXTURE           CATALYST OUTLET TEMP (DEG F)          781          RESIDENCE TIME (SECONDS)             0.020
                  CATALYST BED TEMP RISE (DEG F)         31          CATALYST BED PRESS DROP (" H2O)
                  MAIN HEATER TEMPERATURE (DEG F)

                                                 AVERAGE MEASURED         DESTRUCTION EFFICIENCY (%)
                                  CALCULATED   CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                           INLET CONC   ----------------------              STD.       95% C.I.
 CODE        SPECIES               (PPMV-C)      INLET      OUTLET        MEAN     DEV.     ON THE MEAN
-------------------------------------------------------------------------------------------------------------
  2        METHYL ETHYL KETONE       1190         1281       47.9         96.26    0.083   ( 96.19, 96.33)


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RUN #    A-20     CATALYST INLET TEMP (DEG F)           751          SPACE VELOCITY                      49,576
MIXTURE           CATALYST OUTLET TEMP (DEG F)          787          RESIDENCE TIME (SECONDS)             0.020
                  CATALYST BED TEMP RISE (DEG F)         36          CATALYST BED PRESS DROP (" H2O)
                  MAIN HEATER TEMPERATURE (DEG F)

                                                 AVERAGE MEASURED         DESTRUCTION EFFICIENCY (%)
                                  CALCULATED   CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                           INLET CONC   ----------------------              STD.       95% C.I.
 CODE        SPECIES               (PPMV-C)      INLET      OUTLET        MEAN     DEV.     ON THE MEAN
-------------------------------------------------------------------------------------------------------------
  3        ETHYL ACETATE             1207         1230       34.4         97.20    0.097   ( 97.11, 97.29)


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RUN #    A-21       CATALYST INLET TEMP (DEG F)          750            SPACE VELOCITY                          49,478
MIXTURE             CATALYST OUTLET TEMP (DEG F)         899            RESIDENCE TIME (SECONDS)                 0.019
                    CATALYST BED TEMP RISE (DEG F)       149            CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
 SPECIES                              INLET CONC   ----------------------               STD.      95% C.I.
  CODE       SPECIES                   (PPMV-C)      INLET      OUTLET        MEAN      DEV.    ON THE MEAN
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   4       BENZENE                       6408         5839      440.1         92.46     0.163   ( 92.31, 92.61)


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RUN #    A-22       CATALYST INLET TEMP (DEG F)          752            SPACE VELOCITY                          49,674
MIXTURE             CATALYST OUTLET TEMP (DEG F)         882            RESIDENCE TIME (SECONDS)                 0.019
                    CATALYST BED TEMP RISE (DEG F)       130            CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
 SPECIES                              INLET CONC   ----------------------               STD.      95% C.I.
  CODE       SPECIES                   (PPMV-C)      INLET      OUTLET        MEAN      DEV.    ON THE MEAN
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   3       ETHYL ACETATE                 6071         6142      168.6         97.25     0.129   ( 97.12, 97.38)


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RUN #    A-23      CATALYST INLET TEMP (DEG F)          750       SPACE VELOCITY                      49,870
MIXTURE            CATALYST OUTLET TEMP (DEG F)         883       RESIDENCE TIME (SECONDS)             0.019
                   CATALYST BED TEMP RISE (DEG F)       133       CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                     CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
SPECIES                              INLET CONC   ----------------------               STD.       95% C.I.
 CODE       SPECIES                   (PPMV-C)       INLET      OUTLET       MEAN      DEV.     ON THE MEAN
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  5        N-HEXANE                     5990         6600       296.3        95.51     0.118   ( 95.39, 95.64)


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RUN #    A-24      CATALYST INLET TEMP (DEG F)          750       SPACE VELOCITY                      49,381
MIXTURE            CATALYST OUTLET TEMP (DEG F)         795       RESIDENCE TIME (SECONDS)             0.020
                   CATALYST BED TEMP RISE (DEG F)        45       CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                     CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
SPECIES                              INLET CONC   ----------------------               STD.       95% C.I.
 CODE       SPECIES                   (PPMV-C)       INLET      OUTLET       MEAN      DEV.     ON THE MEAN
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  5        N-HEXANE                     1217         1303        81.8        93.72     0.169   ( 93.57, 93.88)


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RUN #    A-25       CATALYST INLET TEMP (DEG F)          752          SPACE VELOCITY                       49,674
MIXTURE             CATALYST OUTLET TEMP (DEG F)         794          RESIDENCE TIME (SECONDS)              0.020
                    CATALYST BED TEMP RISE (DEG F)        42          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                      AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)   -----------------------------------
 SPECIES                               INLET CONC   ----------------------                STD.        95% C.I.
  CODE        SPECIES                   (PPMV-C)      INLET      OUTLET       MEAN        DEV.      ON THE MEAN
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   6        CYCLOHEXANE                   1131         1174       164.9       85.96       0.413    ( 85.57, 86.34)


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RUN #    A-26       CATALYST INLET TEMP (DEG F)          752          SPACE VELOCITY                       49,674
MIXTURE             CATALYST OUTLET TEMP (DEG F)         903          RESIDENCE TIME (SECONDS)              0.019
                    CATALYST BED TEMP RISE (DEG F)       151          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                      AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)   -----------------------------------
 SPECIES                               INLET CONC   ----------------------                STD.        95% C.I.
  CODE        SPECIES                   (PPMV-C)      INLET      OUTLET       MEAN        DEV.      ON THE MEAN
 ------------------------------------------------------------------------------------------------------------
   6        CYCLOHEXANE                   5897         6176       713.9       88.44       0.095    ( 88.37, 88.51)


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RUN #    A-27       CATALYST INLET TEMP (DEG F)          755          SPACE VELOCITY                         49,674
MIXTURE  1A         CATALYST OUTLET TEMP (DEG F)         877          RESIDENCE TIME (SECONDS)                0.019
                    CATALYST BED TEMP RISE (DEG F)       122          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)    ---------------------------------
 SPECIES                               INLET CONC   ----------------------               STD.        95% C.I.
  CODE        SPECIES                   (PPMV-C)      INLET      OUTLET        MEAN      DEV.     ON THE MEAN
 ---------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                   1252         1281        54.0        95.79     0.078    ( 95.72, 95.86)
   2        METHYL ETHYL KETONE           1246         1282        47.0        96.34     0.083    ( 96.26, 96.41)
   3        ETHYL ACETATE                 1246         1278        31.9        97.51     0.212    ( 97.31, 97.70)
   4        BENZENE                       1241         1219        97.7        91.99     0.072    ( 91.92, 92.06)
   6        CYCLOHEXANE                   1236         1302       141.0        89.17     0.299    ( 88.90, 89.45)

  99        TOTAL HC                      6221         6364       371.5        94.16     0.142    ( 94.03, 94.29)


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RUN #    A-29       CATALYST INLET TEMP (DEG F)          749          SPACE VELOCITY                         49,283
MIXTURE             CATALYST OUTLET TEMP (DEG F)         790          RESIDENCE TIME (SECONDS)                0.020
                    CATALYST BED TEMP RISE (DEG F)        41          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)    ---------------------------------
 SPECIES                               INLET CONC   ----------------------               STD.        95% C.I.
  CODE        SPECIES                   (PPMV-C)      INLET      OUTLET        MEAN      DEV.     ON THE MEAN
 ---------------------------------------------------------------------------------------------------------------

   7        ISOOCTANE                     1279         1368       270.5        80.24     0.183    ( 80.04, 80.43)


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RUN #    A-30       CATALYST INLET TEMP (DEG F)          749           SPACE VELOCITY                          49,283
MIXTURE             CATALYST OUTLET TEMP (DEG F)         896           RESIDENCE TIME (SECONDS)                 0.019
                    CATALYST BED TEMP RISE (DEG F)       147           CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                        CALCULATED    CONCENTRATION (PPMV-C)     -----------------------------------
SPECIES                                 INLET CONC    ----------------------                 STD.        95% C.I.
 CODE        SPECIES                    (PPMV-C)        INLET      OUTLET          MEAN      DEV.      ON THE MEAN
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  7         ISOOCTANE                      5852          6023      1025.8          82.97     0.216    ( 82.75, 83.19)


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RUN #    A-31       CATALYST INLET TEMP (DEG F)          749           SPACE VELOCITY                          49,870
MIXTURE  1B         CATALYST OUTLET TEMP (DEG F)         859           RESIDENCE TIME (SECONDS)                 0.019
                    CATALYST BED TEMP RISE (DEG F)       110           CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                        CALCULATED    CONCENTRATION (PPMV-C)     -----------------------------------
SPECIES                                 INLET CONC    ----------------------                 STD.        95% C.I.
 CODE        SPECIES                    (PPMV-C)        INLET      OUTLET          MEAN      DEV.      ON THE MEAN
---------------------------------------------------------------------------------------------------------------------

  1         ISOPROPANOL                    1119          1156        46.8          95.96     0.077    ( 95.88, 96.04)
  2         METHYL ETHYL KETONE            1117          1147        37.9          96.70     0.048    ( 96.65, 96.75)
  3         ETHYL ACETATE                  1117          1163        24.8          97.86     0.037    ( 97.82, 97.90)
  4         BENZENE                        1120          1141        89.9          92.12     0.049    ( 92.07, 92.17)
  7         ISOOCTANE                      1106          1127       189.0          83.23     0.211    ( 83.00, 83.45)

 99         TOTAL HC                       5579          5735       388.4          93.23     0.036    ( 93.19, 93.27)


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RUN #    A-32       CATALYST INLET TEMP (DEG F)         583          SPACE VELOCITY                          32,660
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)        713          RESIDENCE TIME (SECONDS)                 0.034
                    CATALYST BED TEMP RISE (DEG F)      130          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                               INLET CONC   ----------------------              STD.       95% C.I.
 CODE        SPECIES                  (PPMV-C)      INLET      OUTLET         MEAN     DEV.     ON THE MEAN
----------------------------------------------------------------------------------------------------------------

  1       ISOPROPANOL                   1221         1245        54.8         95.60    0.040   ( 95.56, 95.64)
  2       METHYL ETHYL KETONE           1217         1252        43.3         96.54    0.045   ( 96.49, 96.59)
  3       ETHYL ACETATE                 1219         1256        64.1         94.90    0.088   ( 94.80, 94.99)
  4       BENZENE                       1226         1228        68.2         94.44    0.054   ( 94.39, 94.50)
  5       N-HEXANE                      1222         1211       163.5         86.50    0.273   ( 86.21, 86.78)

 99       TOTAL HC                      6105         6193       394.0         93.64    0.085   ( 93.55, 93.73)


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RUN #    A-33       CATALYST INLET TEMP (DEG F)         584          SPACE VELOCITY                          32,562
MIXTURE             CATALYST OUTLET TEMP (DEG F)        617          RESIDENCE TIME (SECONDS)                 0.036
                    CATALYST BED TEMP RISE (DEG F)       33          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                               INLET CONC   ----------------------              STD.       95% C.I.
 CODE        SPECIES                  (PPMV-C)      INLET      OUTLET         MEAN     DEV.     ON THE MEAN
----------------------------------------------------------------------------------------------------------------

  5       N-HEXANE                      1200         1222        78.8         93.55    0.091   ( 93.47, 93.64)


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RUN #    A-34       CATALYST INLET TEMP (DEG F)          579          SPACE VELOCITY                        49,674
MIXTURE             CATALYST OUTLET TEMP (DEG F)         622          RESIDENCE TIME (SECONDS)               0.023
                    CATALYST BED TEMP RISE (DEG F)        43          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)    ------------------------------
SPECIES                                  INLET CONC   ----------------------             STD.      95% C.I.
 CODE        SPECIES                     (PPMV-C)       INLET      OUTLET        MEAN    DEV.    ON THE MEAN
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  7        ISOOCTANE                        1270         1337       329.0        75.39   0.330  ( 75.04, 75.73)


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RUN #    A-35       CATALYST INLET TEMP (DEG F)          584          SPACE VELOCITY                        49,674
MIXTURE             CATALYST OUTLET TEMP (DEG F)         730          RESIDENCE TIME (SECONDS)               0.022
                    CATALYST BED TEMP RISE (DEG F)       146          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)    ------------------------------
SPECIES                                  INLET CONC   ----------------------             STD.      95% C.I.
 CODE        SPECIES                     (PPMV-C)       INLET      OUTLET        MEAN    DEV.    ON THE MEAN
------------------------------------------------------------------------------------------------------------
  7        ISOOCTANE                        5857         5993      1200.9        79.97   0.123  ( 79.85, 80.08)


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RUN #    A-36       CATALYST INLET TEMP (DEG F)          585           SPACE VELOCITY                          49,381
MIXTURE  1B         CATALYST OUTLET TEMP (DEG F)         715           RESIDENCE TIME (SECONDS)                 0.022
                    CATALYST BED TEMP RISE (DEG F)       130           CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                            AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                         CALCULATED      CONCENTRATION (PPMV-C)      ------------------------------------
SPECIES                                  INLET CONC      ----------------------                 STD.        95% C.I.
 CODE         SPECIES                    (PPMV-C)          INLET      OUTLET            MEAN     DEV.      ON THE MEAN
--------------------------------------------------------------------------------------------------------------------
  1         ISOPROPANOL                    1124            1124        117.9           89.52    0.059    ( 89.47, 89.58)
  2         METHYL ETHYL KETONE            1121            1126         99.6           91.16    0.096    ( 91.07, 91.25)
  3         ETHYL ACETATE                  1121            1145        133.7           88.33    0.105    ( 88.24, 88.43)
  4         BENZENE                        1125            1097        101.0           90.79    0.042    ( 90.75, 90.83)
  7         ISOOCTANE                      1111            1137        243.6           78.59    0.258    ( 78.35, 78.83)

 99         TOTAL HC                       5602            5631        695.8           87.65    0.074    ( 87.58, 87.72)


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RUN #    A-37       CATALYST INLET TEMP (DEG F)          583           SPACE VELOCITY                          48,403
MIXTURE             CATALYST OUTLET TEMP (DEG F)         611           RESIDENCE TIME (SECONDS)                 0.024
                    CATALYST BED TEMP RISE (DEG F)        28           CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                            AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                         CALCULATED      CONCENTRATION (PPMV-C)      ------------------------------------
SPECIES                                  INLET CONC      ----------------------                 STD.        95% C.I.
 CODE         SPECIES                    (PPMV-C)          INLET      OUTLET            MEAN     DEV.      ON THE MEAN
--------------------------------------------------------------------------------------------------------------------
 31         N-OCTANE                       1261            1338         41.7           96.88    0.167    ( 96.71, 97.06)


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RUN #    A-38       CATALYST INLET TEMP (DEG F)          583           SPACE VELOCITY                         49,674
MIXTURE  1C         CATALYST OUTLET TEMP (DEG F)         706           RESIDENCE TIME (SECONDS)                0.022
                    CATALYST BED TEMP RISE (DEG F)       123           CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                        CALCULATED   CONCENTRATION (PPMV-C)     -----------------------------------
 SPECIES                                INLET CONC   ----------------------                STD.        95% C.I.
  CODE        SPECIES                    (PPMV-C)      INLET      OUTLET          MEAN      DEV.      ON THE MEAN
---------------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                    1090         1181       105.3          91.08     0.140    ( 90.94, 91.23)
   2        METHYL ETHYL KETONE            1087         1153        95.9          91.69     0.136    ( 91.54, 91.83)
   3        ETHYL ACETATE                  1087         1162       134.3          88.44     0.205    ( 88.23, 88.66)
   4        BENZENE                        1091         1080        92.1          91.46     0.303    ( 91.14, 91.78)
  31        N-OCTANE                       1085         1105       197.0          82.19     0.378    ( 81.79, 82.58)

  99        TOTAL HC                       5440         5683       624.7          89.01     0.198    ( 88.80, 89.22)


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RUN #    A-39       CATALYST INLET TEMP (DEG F)          583           SPACE VELOCITY                         49,674
MIXTURE             CATALYST OUTLET TEMP (DEG F)         699           RESIDENCE TIME (SECONDS)                0.023
                    CATALYST BED TEMP RISE (DEG F)       116           CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                        CALCULATED   CONCENTRATION (PPMV-C)     -----------------------------------
 SPECIES                                INLET CONC   ----------------------                STD.        95% C.I.
  CODE        SPECIES                    (PPMV-C)      INLET      OUTLET          MEAN      DEV.      ON THE MEAN
---------------------------------------------------------------------------------------------------------------------

  31        N-OCTANE                       5765         5932       156.5          97.36     0.046    ( 97.31, 97.41)


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RUN # A-40
MIXTURE 1

CATALYST INLET TEMP (DEG F) 583
CATALYST OUTLET TEMP (DEG F) 643
CATALYST BED TEMP RISE (DEG F) 60
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,772
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	241	241	31.4	86.99	0.279	(86.73, 87.25)
2	METHYL ETHYL KETONE	240	242	25.1	89.64	0.301	(89.36, 89.91)
3	ETHYL ACETATE	241	240	32.5	86.51	0.365	(86.17, 86.85)
4	BENZENE	242	242	25.3	89.52	0.278	(89.27, 89.78)
5	N-HEXANE	239	245	65.1	73.48	0.767	(72.77, 74.19)
99	TOTAL HC	1203	1212	179.4	85.19	0.396	(84.83, 85.56)

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RUN # A-41
MIXTURE

CATALYST INLET TEMP (DEG F) 582
CATALYST OUTLET TEMP (DEG F) 744
CATALYST BED TEMP RISE (DEG F) 162
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,870
RESIDENCE TIME (SECONDS) 0.022
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
5	N-HEXANE	5954	6453	375.2	94.19	0.117	(94.06, 94.31)

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RUN #    A-42      CATALYST INLET TEMP (DEG F)          581          SPACE VELOCITY                        49,870
MIXTURE            CATALYST OUTLET TEMP (DEG F)         640          RESIDENCE TIME (SECONDS)               0.023
                   CATALYST BED TEMP RISE (DEG F)        59          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                        CALCULATED  CONCENTRATION (PPMV-C)     -----------------------------------
 SPECIES                                INLET CONC  ----------------------                 STD.        95% C.I.
  CODE         SPECIES                   (PPMV-C)     INLET       OUTLET         MEAN      DEV.      ON THE MEAN
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    4        BENZENE                        1093        1031        100.2        90.28     0.077    ( 90.20, 90.36)


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RUN #    A-43      CATALYST INLET TEMP (DEG F)          581          SPACE VELOCITY                        49,870
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)         754          RESIDENCE TIME (SECONDS)               0.022
                   CATALYST BED TEMP RISE (DEG F)       173          CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                        CALCULATED  CONCENTRATION (PPMV-C)     -----------------------------------
 SPECIES                                INLET CONC  ----------------------                 STD.        95% C.I.
  CODE         SPECIES                   (PPMV-C)     INLET       OUTLET         MEAN      DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------

    1        ISOPROPANOL                    1219        1213        117.2        90.35     0.157    ( 90.18, 90.51)
    2        METHYL ETHYL KETONE            1214        1226        113.0        90.78     0.160    ( 90.61, 90.95)
    3        ETHYL ACETATE                  1217        1218        137.0        88.76     0.176    ( 88.57, 88.94)
    4        BENZENE                        1223        1218        104.2        91.45     0.105    ( 91.34, 91.56)
    5        N-HEXANE                       1219        1225        219.2        82.11     0.289    ( 81.81, 82.42)

   99        TOTAL HC                       6092        6102        690.5        88.68     0.175    ( 88.50, 88.87)


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RUN # B-1
MIXTURE 1

CATALYST INLET TEMP (DEG F) 498
CATALYST OUTLET TEMP (DEG F) 658
CATALYST BED TEMP RISE (DEG F) 130
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,381
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	1202	1223	176.3	85.56	0.713	(84.90, 86.22)
2	METHYL ETHYL KETONE	1198	1229	160.4	86.93	0.627	(86.35, 87.51)
3	ETHYL ACETATE	1201	1232	213.0	82.69	0.893	(81.86, 83.51)
4	BENZENE	1207	1201	122.4	89.80	0.483	(89.35, 90.24)
5	N-HEXANE	1194	1190	292.1	75.42	1.243	(74.27, 76.57)
99	TOTAL HC	6002	6078	964.3	84.11	0.785	(83.38, 84.83)

RUN # B-2
MIXTURE 1

CATALYST INLET TEMP (DEG F) 498
CATALYST OUTLET TEMP (DEG F) 549
CATALYST BED TEMP RISE (DEG F) 21
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,478
RESIDENCE TIME (SECONDS) 0.025
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	236	239	53.6	77.63	0.825	(76.86, 78.39)
2	METHYL ETHYL KETONE	235	240	39.0	83.79	0.642	(83.19, 84.38)
3	ETHYL ACETATE	235	241	65.4	72.88	0.987	(71.96, 73.79)
4	BENZENE	237	239	31.1	87.00	0.431	(86.60, 87.40)
5	N-HEXANE	234	243	106.7	56.16	1.706	(54.59, 57.74)
99	TOTAL HC	1177	1205	295.9	75.43	0.903	(74.59, 76.27)

RUN # B-3
MIXTURE 1

CATALYST INLET TEMP (DEG F) 542
CATALYST OUTLET TEMP (DEG F) 698
CATALYST BED TEMP RISE (DEG F) 156
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 79,498
RESIDENCE TIME (SECONDS) 0.014
CATALYST BED PRESS DROP (" H2O) 2.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	1215	1202	260.3	78.37	1.084	(77.36, 79.37)
2	METHYL ETHYL KETONE	1211	1225	243.1	80.16	1.030	(79.21, 81.12)
3	ETHYL ACETATE	1213	1225	293.4	76.06	1.257	(74.90, 77.22)
4	BENZENE	1219	1193	189.9	84.09	0.773	(83.37, 84.80)
5	N-HEXANE	1206	1186	378.6	68.09	1.528	(66.68, 69.50)
99	TOTAL HC	6064	6032	1365.3	77.37	1.131	(76.33, 78.42)

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RUN # B-4
MIXTURE 1

CATALYST INLET TEMP (DEG F) 539
CATALYST OUTLET TEMP (DEG F) 675
CATALYST BED TEMP RISE (DEG F) 136
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 33,051
RESIDENCE TIME (SECONDS) 0.035
CATALYST BED PRESS DROP (" H2O) 0.8

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	1215	1178	71.3	93.94	0.228	(93.73, 94.16)
2	METHYL ETHYL KETONE	1210	1194	59.2	95.04	0.206	(94.85, 95.23)
3	ETHYL ACETATE	1213	1195	86.7	92.74	0.288	(92.47, 93.01)
4	BENZENE	1219	1166	64.8	94.44	0.198	(94.25, 94.62)
5	N-HEXANE	1206	1169	167.4	85.67	0.525	(85.19, 86.16)
99	TOTAL HC	6063	5904	449.5	92.38	0.286	(92.12, 92.65)

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RUN #    B-5        CATALYST INLET TEMP (DEG F)        569          SPACE VELOCITY                      79,987
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)       582          RESIDENCE TIME (SECONDS)             0.015
                    CATALYST BED TEMP RISE (DEG F)      13          CATALYST BED PRESS DROP (" H2O)        1.9
                    MAIN HEATER TEMPERATURE (DEG F)

                                                    AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
SPECIES                               INLET CONC   ----------------------             STD.       95% C.I.
 CODE        SPECIES                  (PPMV-C)      INLET      OUTLET         MEAN    DEV.     ON THE MEAN
---------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                  236          245        69.5         71.69   0.398   ( 71.32, 72.06)
   2        METHYL ETHYL KETONE          235          249        54.5         78.14   0.351   ( 77.81, 78.46)
   3        ETHYL ACETATE                235          248        73.7         70.36   0.572   ( 69.83, 70.89)
   4        BENZENE                      236          244        44.2         81.94   0.361   ( 81.61, 82.28)
   5        N-HEXANE                     234          238       107.7         54.77   0.959   ( 53.88, 55.65)

  99        TOTAL HC                    1176         1226       349.6         71.49   0.487   ( 71.04, 71.94)


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RUN #    B-6        CATALYST INLET TEMP (DEG F)        567          SPACE VELOCITY                      32,953
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)       582          RESIDENCE TIME (SECONDS)             0.036
                    CATALYST BED TEMP RISE (DEG F)      15          CATALYST BED PRESS DROP (" H2O)        0.8
                    MAIN HEATER TEMPERATURE (DEG F)

                                                    AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
SPECIES                               INLET CONC   ----------------------             STD.       95% C.I.
 CODE        SPECIES                  (PPMV-C)      INLET      OUTLET         MEAN    DEV.     ON THE MEAN
---------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                  239          252        18.9         92.51   0.437   ( 92.05, 92.96)
   2        METHYL ETHYL KETONE          238          255        12.3         95.16   0.257   ( 94.89, 95.43)
   3        ETHYL ACETATE                238          255        20.8         91.85   0.437   ( 91.40, 92.31)
   4        BENZENE                      239          251        16.2         93.54   0.254   ( 93.27, 93.80)
   5        N-HEXANE                     237          251        55.6         77.84   0.740   ( 77.06, 78.61)

  99        TOTAL HC                    1191         1266       124.0         90.21   0.400   ( 89.79, 90.62)
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RUN #    B-7        CATALYST INLET TEMP (DEG F)          580            SPACE VELOCITY                      49,870
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)         719            RESIDENCE TIME (SECONDS)             0.022
                    CATALYST BED TEMP RISE (DEG F)       139            CATALYST BED PRESS DROP (" H2O)        1.2
                    MAIN HEATER TEMPERATURE (DEG F)

                                                       AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                       CALCULATED    CONCENTRATION (PPMV-C)   ----------------------------------
SPECIES                                INLET CONC    ----------------------               STD.       95% C.I.
 CODE        SPECIES                    (PPMV-C)       INLET      OUTLET        MEAN      DEV.     ON THE MEAN
--------------------------------------------------------------------------------------------------------------

  1       ISOPROPANOL                     1229          1127       111.8        90.08     0.183   ( 89.89, 90.28)
  2       METHYL ETHYL KETONE             1225          1141        98.4        91.37     0.093   ( 91.27, 91.47)
  3       ETHYL ACETATE                   1227          1149       128.2        88.85     0.115   ( 88.73, 88.97)
  4       BENZENE                         1233          1117        99.9        91.06     0.077   ( 90.98, 91.14)
  5       N-HEXANE                        1220          1129       214.3        81.02     0.202   ( 80.81, 81.24)

 99       TOTAL HC                        6133          5665       652.7        88.48     0.123   ( 88.35, 88.61)


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RUN #    B-9        CATALYST INLET TEMP (DEG F)          578            SPACE VELOCITY                      48,892
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)         605            RESIDENCE TIME (SECONDS)             0.024
                    CATALYST BED TEMP RISE (DEG F)        27            CATALYST BED PRESS DROP (" H2O)        1.0
                    MAIN HEATER TEMPERATURE (DEG F)

                                                       AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                       CALCULATED    CONCENTRATION (PPMV-C)   ----------------------------------
SPECIES                                INLET CONC    ----------------------               STD.       95% C.I.
 CODE        SPECIES                    (PPMV-C)       INLET      OUTLET        MEAN      DEV.     ON THE MEAN
--------------------------------------------------------------------------------------------------------------

  1       ISOPROPANOL                      232           242        29.6        87.77     0.265   ( 87.53, 88.02)
  2       METHYL ETHYL KETONE              232           241        21.8        91.00     0.230   ( 90.78, 91.21)
  3       ETHYL ACETATE                    232           243        31.0        87.28     0.335   ( 86.97, 87.59)
  4       BENZENE                          233           239        25.1        89.54     0.143   ( 89.41, 89.67)
  5       N-HEXANE                         231           241        63.0        73.87     0.428   ( 73.48, 74.27)

 99       TOTAL HC                        1160          1208       170.4        85.90     0.275   ( 85.64, 86.15)
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RUN #    B-10      CATALYST INLET TEMP (DEG F)          578         SPACE VELOCITY                        49,625
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)         713         RESIDENCE TIME (SECONDS)               0.022
                   CATALYST BED TEMP RISE (DEG F)       135         CATALYST BED PRESS DROP (" H2O)          1.0
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
SPECIES                               INLET CONC   ----------------------             STD.      95% C.I.
 CODE       SPECIES                   (PPMV-C)      INLET      OUTLET        MEAN     DEV.     ON THE MEAN
----------------------------------------------------------------------------------------------------------

  1        ISOPROPANOL                   1187         1179      113.0        90.42    0.107   ( 90.32, 90.52)
  2        METHYL ETHYL KETONE           1183         1185      101.9        91.40    0.107   ( 91.30, 91.50)
  3        ETHYL ACETATE                 1185         1195      134.1        88.78    0.086   ( 88.70, 88.86)
  4        BENZENE                       1191         1163      100.7        91.34    0.062   ( 91.29, 91.40)
  5        N-HEXANE                      1179         1185      214.3        81.92    0.178   ( 81.76, 82.09)

 99        TOTAL HC                      5926         5908      664.0        88.76    0.105   ( 88.66, 88.86)


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RUN #    B-11      CATALYST INLET TEMP (DEG F)          678         SPACE VELOCITY                        79,596
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)         807         RESIDENCE TIME (SECONDS)               0.013
                   CATALYST BED TEMP RISE (DEG F)       129         CATALYST BED PRESS DROP (" H2O)          2.1
                   MAIN HEATER TEMPERATURE (DEG F)

                                                     AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   ----------------------------------
SPECIES                               INLET CONC   ----------------------             STD.      95% C.I.
 CODE       SPECIES                   (PPMV-C)      INLET      OUTLET        MEAN     DEV.     ON THE MEAN
----------------------------------------------------------------------------------------------------------

  1        ISOPROPANOL                   1184         1151      139.1        87.91    0.221   ( 87.71, 88.12)
  2        METHYL ETHYL KETONE           1180         1156      125.4        89.15    0.177   ( 88.99, 89.31)
  3        ETHYL ACETATE                 1182         1166      154.4        86.76    0.253   ( 86.52, 86.99)
  4        BENZENE                       1188         1131      150.4        86.71    0.210   ( 86.51, 86.90)
  5        N-HEXANE                      1176         1139      264.4        76.79    0.404   ( 76.42, 77.16)

 99        TOTAL HC                      5910         5745      833.9        85.48    0.251   ( 85.25, 85.72)
```

RUN #	B-12	CATALYST INLET TEMP (DEG F)	678	SPACE VELOCITY	32,953
MIXTURE	1	CATALYST OUTLET TEMP (DEG F)	783	RESIDENCE TIME (SECONDS)	0.031
		CATALYST BED TEMP RISE (DEG F)	105	CATALYST BED PRESS DROP (" H2O)	0.8
		MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
1	ISOPROPANOL	1271	1258	22.2	98.23	0.031	(98.20, 98.27)
2	METHYL ETHYL KETONE	1266	1270	18.3	98.56	0.022	(98.54, 98.58)
3	ETHYL ACETATE	1269	1280	7.6	99.41	0.028	(99.38, 99.44)
4	BENZENE	1275	1244	50.8	95.92	0.096	(95.81, 96.02)
5	N-HEXANE	1262	1270	96.9	92.37	0.184	(92.18, 92.56)
99	TOTAL HC	6342	6324	195.8	96.90	0.068	(96.83, 96.97)

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RUN #	B-13	CATALYST INLET TEMP (DEG F)	678	SPACE VELOCITY	79,987
MIXTURE	1	CATALYST OUTLET TEMP (DEG F)	705	RESIDENCE TIME (SECONDS)	0.013
		CATALYST BED TEMP RISE (DEG F)	27	CATALYST BED PRESS DROP (" H2O)	2.1
		MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
1	ISOPROPANOL	235	241	31.6	86.90	0.588	(86.28, 87.51)
2	METHYL ETHYL KETONE	234	242	25.1	89.63	0.493	(89.11, 90.14)
3	ETHYL ACETATE	235	244	31.4	87.14	0.599	(86.51, 87.77)
4	BENZENE	236	240	35.4	85.24	0.627	(84.58, 85.90)
5	N-HEXANE	233	245	68.6	71.98	1.403	(70.51, 73.45)
99	TOTAL HC	1173	1214	192.2	84.15	0.725	(83.39, 84.91)

```
RUN #    B-14      CATALYST INLET TEMP (DEG F)        588           SPACE VELOCITY                          49,674
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)       717           RESIDENCE TIME (SECONDS)                 0.022
                   CATALYST BED TEMP RISE (DEG F)     129           CATALYST BED PRESS DROP (" H2O)            1.0
                   MAIN HEATER TEMPERATURE (DEG F)

                                                    AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                     CALCULATED   CONCENTRATION (PPMV-C)     -----------------------------------
SPECIES                              INLET CONC   ----------------------                STD.        95% C.I.
 CODE          SPECIES                (PPMV-C)      INLET      OUTLET        MEAN       DEV.      ON THE MEAN
--------------------------------------------------------------------------------------------------------------

   1      ISOPROPANOL                   1187         1300       119.7        90.80     0.101    ( 90.70, 90.89)
   2      METHYL ETHYL KETONE           1183         1310       104.4        92.03     0.131    ( 91.91, 92.15)
   3      ETHYL ACETATE                 1185         1287       140.0        89.13     0.132    ( 89.01, 89.25)
   4      BENZENE                       1191         1290       110.3        91.45     0.116    ( 91.34, 91.56)
   5      N-HEXANE                      1179         1278       230.0        82.00     0.240    ( 81.78, 82.22)

  99      TOTAL HC                      5926         6467       704.4        89.11     0.134    ( 88.98, 89.23)


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RUN #    B-15      CATALYST INLET TEMP (DEG F)        689           SPACE VELOCITY                          32,757
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)       707           RESIDENCE TIME (SECONDS)                 0.032
                   CATALYST BED TEMP RISE (DEG F)      18           CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                    AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                     CALCULATED   CONCENTRATION (PPMV-C)     -----------------------------------
SPECIES                              INLET CONC   ----------------------                STD.        95% C.I.
 CODE          SPECIES                (PPMV-C)      INLET      OUTLET        MEAN       DEV.      ON THE MEAN
--------------------------------------------------------------------------------------------------------------

   1      ISOPROPANOL                    235          254         4.2        98.36     0.029    ( 98.33, 98.39)
   2      METHYL ETHYL KETONE            234          257         3.3        98.72     0.194    ( 98.52, 98.92)
   3      ETHYL ACETATE                  235          252        <1.0       >99.60     0.012
   4      BENZENE                        236          256        13.6        94.70     0.082    ( 94.61, 94.78)
   5      N-HEXANE                       234          261        27.1        89.59     0.220    ( 89.36, 89.83)

  99      TOTAL HC                      1174         1282        49.2        96.16     0.076    ( 96.08, 96.24)
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RUN #    B-16       CATALYST INLET TEMP (DEG F)          748           SPACE VELOCITY                     49,772
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)         858           RESIDENCE TIME (SECONDS)            0.020
                    CATALYST BED TEMP RISE (DEG F)       110           CATALYST BED PRESS DROP (" H2O)       1.0
                    MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                  INLET CONC   ----------------------               STD.       95% C.I.
 CODE       SPECIES                       (PPMV-C)      INLET      OUTLET         MEAN     DEV.     ON THE MEAN
------------------------------------------------------------------------------------------------------------------

  1        ISOPROPANOL                      1165         1268       45.5         96.41    0.081   ( 96.33, 96.50)
  2        METHYL ETHYL KETONE              1161         1281       40.8         96.82    0.101   ( 96.71, 96.92)
  3        ETHYL ACETATE                    1163         1256       27.6         97.81    0.091   ( 97.71, 97.90)
  4        BENZENE                          1169         1261       93.3         92.60    0.189   ( 92.40, 92.80)
  5        N-HEXANE                         1157         1260      161.7         87.18    0.292   ( 86.87, 87.48)

 99        TOTAL HC                         5816         6329      368.9         94.17    0.149   ( 94.01, 94.33)


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RUN #    B-17       CATALYST INLET TEMP (DEG F)          748           SPACE VELOCITY                     49,674
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)         771           RESIDENCE TIME (SECONDS)            0.020
                    CATALYST BED TEMP RISE (DEG F)        23           CATALYST BED PRESS DROP (" H2O)       1.0
                    MAIN HEATER TEMPERATURE (DEG F)

                                                        AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                  INLET CONC   ----------------------               STD.       95% C.I.
 CODE       SPECIES                       (PPMV-C)      INLET      OUTLET         MEAN     DEV.     ON THE MEAN
------------------------------------------------------------------------------------------------------------------

  1        ISOPROPANOL                       234          245        9.8         96.02    0.082   ( 95.93, 96.10)
  2        METHYL ETHYL KETONE               233          247        7.4         97.03    0.039   ( 96.99, 97.07)
  3        ETHYL ACETATE                     234          243        4.5         98.13    0.031   ( 98.10, 98.16)
  4        BENZENE                           235          245       20.4         91.68    0.126   ( 91.55, 91.81)
  5        N-HEXANE                          232          247       38.7         84.37    0.225   ( 84.14, 84.61)

 99        TOTAL HC                         1168         1229       80.8         93.42    0.092   ( 93.33, 93.52)
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RUN #     C-1        CATALYST INLET TEMP (DEG F)         490          SPACE VELOCITY                        39,993
MIXTURE   2          CATALYST OUTLET TEMP (DEG F)        732          RESIDENCE TIME (SECONDS)               0.029
                     CATALYST BED TEMP RISE (DEG F)      242          CATALYST BED PRESS DROP (" H2O)          1.0
                     MAIN HEATER TEMPERATURE (DEG F)

                                                      AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                        CALCULATED  CONCENTRATION (PPMV-C)   -----------------------------------
 SPECIES                                INLET CONC  ----------------------              STD.        95% C.I.
  CODE       SPECIES                    (PPMV-C)     INLET       OUTLET        MEAN     DEV.      ON THE MEAN
--------------------------------------------------------------------------------------------------------------

   2       METHYL ETHYL KETONE            4352        4221        335.5        92.04    0.290    ( 91.73, 92.34)
   8       TOLUENE                        5209        5130        398.0        92.22    0.394    ( 91.81, 92.63)

  99       TOTAL HC                       9562        9352        733.5        92.14    0.346    ( 91.77, 92.50)


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RUN #     C-2        CATALYST INLET TEMP (DEG F)         539          SPACE VELOCITY                        39,798
MIXTURE   2          CATALYST OUTLET TEMP (DEG F)        788          RESIDENCE TIME (SECONDS)               0.028
                     CATALYST BED TEMP RISE (DEG F)      249          CATALYST BED PRESS DROP (" H2O)          1.0
                     MAIN HEATER TEMPERATURE (DEG F)

                                                      AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                        CALCULATED  CONCENTRATION (PPMV-C)   -----------------------------------
 SPECIES                                INLET CONC  ----------------------              STD.        95% C.I.
  CODE       SPECIES                    (PPMV-C)     INLET       OUTLET        MEAN     DEV.      ON THE MEAN
--------------------------------------------------------------------------------------------------------------

   2       METHYL ETHYL KETONE            4332        4252        271.5        93.62    0.417    ( 93.18, 94.06)
   8       TOLUENE                        5184        5118        361.8        92.94    0.393    ( 92.53, 93.35)

  99       TOTAL HC                       9516        9371        633.3        93.25    0.404    ( 92.82, 93.67)


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RUN # C-3
MIXTURE 2

CATALYST INLET TEMP (DEG F) 640
CATALYST OUTLET TEMP (DEG F) 854
CATALYST BED TEMP RISE (DEG F) 214
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 39,407
RESIDENCE TIME (SECONDS) 0.026
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	4338	4278	143.8	96.63	0.221	(96.40, 96.86)
8	TOLUENE	5192	5089	320.2	93.70	0.277	(93.41, 93.99)
99	TOTAL HC	9531	9367	464.0	95.04	0.256	(94.77, 95.30)

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RUN # C-4
MIXTURE 1

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 628
CATALYST BED TEMP RISE (DEG F) 30
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 48,990
RESIDENCE TIME (SECONDS) 0.024
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	234	246	29.7	87.97	0.367	(87.59, 88.36)
2	METHYL ETHYL KETONE	233	248	22.3	91.01	0.258	(90.74, 91.29)
3	ETHYL ACETATE	234	249	31.2	87.49	0.404	(87.07, 87.91)
4	BENZENE	235	244	28.2	88.46	0.326	(88.12, 88.81)
5	N-HEXANE	232	246	66.4	73.03	1.022	(71.95, 74.10)
99	TOTAL HC	1169	1235	177.8	85.60	0.296	(85.29, 85.91)

RUN # C-5
MIXTURE 3

CATALYST INLET TEMP (DEG F)	648	SPACE VELOCITY	20,535
CATALYST OUTLET TEMP (DEG F)	661	RESIDENCE TIME (SECONDS)	0.054
CATALYST BED TEMP RISE (DEG F)	13	CATALYST BED PRESS DROP (" H2O)	1.0
MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	178	177	<1.0	>99.43	0.049	
3	ETHYL ACETATE	177	179	<1.0	>99.44	0.047	
9	METHANOL	177	197	<1.0	>99.49	0.055	
10	ETHANOL	178	187	<1.0	>99.46	0.054	
12	N-BUTANOL	178	178	<1.0	>99.44	0.045	
14	N-PROPYL ACETATE	178	169	<1.0	>99.41	0.048	
15	ISOBUTYL ACETATE	177	176	<1.0	>99.43	0.043	
99	TOTAL HC	1243	1267	7.0	99.44	0.049	(99.39, 99.50)

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RUN # C-6
MIXTURE 3

CATALYST INLET TEMP (DEG F)	699	SPACE VELOCITY	29,628
CATALYST OUTLET TEMP (DEG F)	719	RESIDENCE TIME (SECONDS)	0.036
CATALYST BED TEMP RISE (DEG F)	20	CATALYST BED PRESS DROP (" H2O)	0.7
MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	178	170	4.7	97.23	0.291	(96.92, 97.54)
3	ETHYL ACETATE	177	173	<1.0	>99.41	0.083	
9	METHANOL	177	196	<1.0	>99.48	0.084	
10	ETHANOL	178	182	<1.0	>99.44	0.088	
12	N-BUTANOL	177	171	<1.0	>99.41	0.079	
14	N-PROPYL ACETATE	177	164	<1.0	>99.38	0.083	
15	ISOBUTYL ACETATE	177	169	<1.0	>99.40	0.085	
99	TOTAL HC	1241	1227	10.7	99.12	0.087	(99.03, 99.21)

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RUN #    C-7        CATALYST INLET TEMP (DEG F)         598          SPACE VELOCITY                        29,726
MIXTURE  3          CATALYST OUTLET TEMP (DEG F)        621          RESIDENCE TIME (SECONDS)               0.039
                    CATALYST BED TEMP RISE (DEG F)       23          CATALYST BED PRESS DROP (" H2O)          0.8
                    MAIN HEATER TEMPERATURE (DEG F)

                                                  AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                   CALCULATED    CONCENTRATION (PPMV-C)     ------------------------------------
 SPECIES                           INLET CONC    ----------------------               STD.        95% C.I.
  CODE       SPECIES               (PPMV-C)         INLET      OUTLET        MEAN     DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL               177            168         9.3         94.48    0.360    ( 94.10, 94.85)
   3        ETHYL ACETATE             176            163        10.5         93.53    0.811    ( 92.68, 94.38)
   9        METHANOL                  177            163         1.4         99.13    0.541    ( 98.56, 99.70)
  10        ETHANOL                   177            170         1.7         99.00    0.266    ( 98.72, 99.28)
  12        N-BUTANOL                 177            147        <2.2        >98.54    0.179
  14        N-PROPYL ACETATE          177            164        11.7         92.85    1.290    ( 91.50, 94.21)
  15        ISOBUTYL ACETATE          176            162         7.3         95.47    0.215    ( 95.25, 95.70)

  99        TOTAL HC                 1238           1139        44.1         96.12    0.291    ( 95.81, 96.42)


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RUN #    C-8        CATALYST INLET TEMP (DEG F)         699          SPACE VELOCITY                        49,576
MIXTURE  3          CATALYST OUTLET TEMP (DEG F)        724          RESIDENCE TIME (SECONDS)               0.021
                    CATALYST BED TEMP RISE (DEG F)       25          CATALYST BED PRESS DROP (" H2O)          1.2
                    MAIN HEATER TEMPERATURE (DEG F)

                                                  AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                   CALCULATED    CONCENTRATION (PPMV-C)     ------------------------------------
 SPECIES                           INLET CONC    ----------------------               STD.        95% C.I.
  CODE       SPECIES               (PPMV-C)         INLET      OUTLET        MEAN     DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL               176            186        15.6         91.59    0.170    ( 91.41, 91.77)
   3        ETHYL ACETATE             175            181        15.3         91.51    0.231    ( 91.26, 91.75)
   9        METHANOL                  175            184         4.1         97.76    0.124    ( 97.63, 97.89)
  10        ETHANOL                   176            190         4.9         97.44    0.116    ( 97.32, 97.56)
  12        N-BUTANOL                 176            163         5.6         96.59    0.210    ( 96.37, 96.81)
  14        N-PROPYL ACETATE          176            179        17.8         90.01    1.763    ( 88.16, 91.86)
  15        ISOBUTYL ACETATE          175            175        13.3         92.42    0.450    ( 91.95, 92.89)

  99        TOTAL HC                 1228           1260        76.8         93.90    0.310    ( 93.58, 94.23)
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RUN # C-9
MIXTURE 3

CATALYST INLET TEMP (DEG F) 798
CATALYST OUTLET TEMP (DEG F) 821
CATALYST BED TEMP RISE (DEG F) 23
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,381
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O) 1.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	177	181	12.6	93.05	0.221	(92.81, 93.28)
3	ETHYL ACETATE	176	175	3.4	98.06	0.125	(97.93, 98.19)
9	METHANOL	177	175	<2.0	>98.86	0.090	
10	ETHANOL	177	182	2.7	98.51	0.087	(98.42, 98.60)
12	N-BUTANOL	177	159	2.3	98.53	0.168	(98.35, 98.70)
14	N-PROPYL ACETATE	177	172	1.0	99.43	0.205	(99.22, 99.65)
15	ISOBUTYL ACETATE	177	172	3.3	98.08	0.110	(97.96, 98.19)
99	TOTAL HC	1239	1218	27.3	97.75	0.113	(97.64, 97.87)

RUN # C-10
MIXTURE 3

CATALYST INLET TEMP (DEG F) 600
CATALYST OUTLET TEMP (DEG F) 631
CATALYST BED TEMP RISE (DEG F) 31
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,478
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O) 1.1

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	172	190	28.0	85.30	0.965	(84.28, 86.31)
3	ETHYL ACETATE	171	176	29.1	83.49	1.126	(82.31, 84.68)
9	METHANOL	171	195	7.1	96.38	0.439	(95.92, 96.85)
10	ETHANOL	172	192	8.8	95.41	0.245	(95.15, 95.67)
12	N-BUTANOL	172	180	10.7	94.08	0.446	(93.61, 94.55)
14	N-PROPYL ACETATE	172	175	25.3	85.58	1.801	(83.69, 87.47)
15	ISOBUTYL ACETATE	171	172	25.3	85.23	2.146	(82.98, 87.48)
99	TOTAL HC	1199	1282	134.3	89.52	0.684	(88.80, 90.24)

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RUN #    C-11       CATALYST INLET TEMP (DEG F)         599          SPACE VELOCITY                      49,381
MIXTURE             CATALYST OUTLET TEMP (DEG F)        627          RESIDENCE TIME (SECONDS)             0.023
                    CATALYST BED TEMP RISE (DEG F)       28          CATALYST BED PRESS DROP (" H2O)        1.1
                    MAIN HEATER TEMPERATURE (DEG F)

                                                         AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                           CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
 SPECIES                                   INLET CONC   ----------------------                STD.      95% C.I.
  CODE        SPECIES                      (PPMV-C)      INLET      OUTLET          MEAN      DEV.    ON THE MEAN
--------------------------------------------------------------------------------------------------------------------

   15      ISOBUTYL ACETATE                  1166         1184       151.3          87.22     0.585   ( 86.61, 87.84)


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RUN #    C-12       CATALYST INLET TEMP (DEG F)         599          SPACE VELOCITY                      49,234
MIXTURE             CATALYST OUTLET TEMP (DEG F)        629          RESIDENCE TIME (SECONDS)             0.023
                    CATALYST BED TEMP RISE (DEG F)       30          CATALYST BED PRESS DROP (" H2O)        1.1
                    MAIN HEATER TEMPERATURE (DEG F)

                                                         AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                           CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
 SPECIES                                   INLET CONC   ----------------------                STD.      95% C.I.
  CODE        SPECIES                      (PPMV-C)      INLET      OUTLET          MEAN      DEV.    ON THE MEAN
--------------------------------------------------------------------------------------------------------------------

   12      N-BUTANOL                         1137         1319        54.4          95.88     0.068   ( 95.81, 95.94)


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RUN # C-13
MIXTURE 4

CATALYST INLET TEMP (DEG F) 599
CATALYST OUTLET TEMP (DEG F) 626
CATALYST BED TEMP RISE (DEG F) 27
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,283
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O) 1.1

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	168	183	23.9	86.83	1.647	(85.10, 88.56)
16	ACETONE	167	185	25.7	86.07	1.353	(84.65, 87.49)
17	METHYL ISOBUTYL KETONE	167	177	19.3	89.02	1.129	(87.83, 90.20)
18	CYCLOHEXANONE	168	177	9.8	94.45	0.553	(93.87, 95.03)
22	ETHYL CELLOSOLVE	167	193	7.9	95.88	0.783	(95.06, 96.70)
23	BUTYL CELLUSOLVE	168	166	6.1	96.36	0.320	(96.03, 96.70)
24	DIOXANE	168	175	26.8	84.58	2.468	(81.99, 87.17)
99	TOTAL HC	1173	1259	119.4	90.45	1.007	(89.39, 91.51)

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RUN # C-14
MIXTURE 4

CATALYST INLET TEMP (DEG F) 701
CATALYST OUTLET TEMP (DEG F) 724
CATALYST BED TEMP RISE (DEG F) 23
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,870
RESIDENCE TIME (SECONDS) 0.021
CATALYST BED PRESS DROP (" H2O) 1.1

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	168	177	13.1	92.58	0.536	(92.02, 93.15)
16	ACETONE	167	174	13.3	92.39	0.160	(92.22, 92.56)
17	METHYL ISOBUTYL KETONE	167	171	10.6	93.83	0.162	(93.66, 94.00)
18	CYCLOHEXANONE	168	172	4.7	97.25	0.067	(97.18, 97.32)
22	ETHYL CELLOSOLVE	167	199	<2.2	>98.90	0.159	
23	BUTYL CELLUSOLVE	168	167	<2.0	>98.80	0.020	
24	DIOXANE	168	170	20.2	88.11	0.981	(87.08, 89.14)
99	TOTAL HC	1172	1233	66.2	94.63	0.243	(94.38, 94.89)

RUN # C-15
MIXTURE 4

CATALYST INLET TEMP (DEG F) 705
CATALYST OUTLET TEMP (DEG F) 719
CATALYST BED TEMP RISE (DEG F) 14
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 29,726
RESIDENCE TIME (SECONDS) 0.035
CATALYST BED PRESS DROP (" H2O) 0.7

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	170	191	5.1	97.30	0.622	(96.65, 97.95)
16	ACETONE	169	193	4.8	97.51	0.240	(97.25, 97.76)
17	METHYL ISOBUTYL KETONE	170	181	5.5	97.00	1.312	(95.62, 98.38)
18	CYCLOHEXANONE	170	182	<2.3	>98.75	0.349	
22	ETHYL CELLOSOLVE	169	219	<2.0	>99.08	0.082	
23	BUTYL CELLUSOLVE	170	179	<2.0	>98.88	0.081	
24	DIOXANE	170	182	8.8	95.16	1.204	(93.90, 96.42)
99	TOTAL HC	1188	1330	30.5	97.70	0.448	(97.23, 98.17)

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RUN # C-16
MIXTURE 4

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 619
CATALYST BED TEMP RISE (DEG F) 21
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 29,726
RESIDENCE TIME (SECONDS) 0.039
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	169	183	9.0	95.10	0.451	(94.62, 95.57)
16	ACETONE	168	186	8.9	95.24	0.189	(95.04, 95.44)
17	METHYL ISOBUTYL KETONE	169	168	11.1	93.40	0.985	(92.37, 94.44)
18	CYCLOHEXANONE	169	168	<5.3	>96.86	0.269	
22	ETHYL CELLOSOLVE	168	158	<5.0	>96.83	0.233	
23	BUTYL CELLUSOLVE	169	156	<5.0	>96.80	0.222	
24	DIOXANE	169	165	12.8	92.29	0.852	(91.39, 93.18)
99	TOTAL HC	1181	1187	57.0	95.20	0.287	(94.90, 95.50)

RUN # C-17
MIXTURE 4

CATALYST INLET TEMP (DEG F) 648
CATALYST OUTLET TEMP (DEG F) 659
CATALYST BED TEMP RISE (DEG F) 11
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 20,143
RESIDENCE TIME (SECONDS) 0.055
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	171	201	<2.0	>99.00	0.037	
16	ACETONE	170	207	<2.0	>99.03	0.034	
17	METHYL ISOBUTYL KETONE	171	177	<2.0	>98.87	0.038	
18	CYCLOHEXANONE	171	178	<5.0	>97.20	0.089	
22	ETHYL CELLOSOLVE	171	192	<5.0	>97.39	0.156	
23	BUTYL CELLUSOLVE	171	176	<5.0	>97.16	0.162	
24	DIOXANE	171	177	<2.0	>98.87	0.038	
99	TOTAL HC	1197	1311	23.0	98.24	0.069	(98.17, 98.32)

RUN # C-18
MIXTURE 4

CATALYST INLET TEMP (DEG F) 798
CATALYST OUTLET TEMP (DEG F) 811
CATALYST BED TEMP RISE (DEG F) 13
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,283
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O) 1.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	169	189	7.8	95.89	0.138	(95.74, 96.03)
16	ACETONE	168	191	9.9	94.82	0.088	(94.73, 94.92)
17	METHYL ISOBUTYL KETONE	168	169	12.6	92.56	0.841	(91.68, 93.44)
18	CYCLOHEXANONE	168	171	6.5	96.21	1.310	(94.83, 97.58)
22	ETHYL CELLOSOLVE	168	183	<5.0	>97.27	0.074	
23	BUTYL CELLUSOLVE	169	172	<5.0	>97.09	0.099	
24	DIOXANE	168	167	15.8	90.55	0.223	(90.32, 90.78)
99	TOTAL HC	1177	1244	62.6	94.97	0.267	(94.69, 95.25)

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RUN #    C-19      CATALYST INLET TEMP (DEG F)          598          SPACE VELOCITY                        49,674
MIXTURE            CATALYST OUTLET TEMP (DEG F)         618          RESIDENCE TIME (SECONDS)               0.023
                   CATALYST BED TEMP RISE (DEG F)        20          CATALYST BED PRESS DROP (" H2O)        1.0
                   MAIN HEATER TEMPERATURE (DEG F)

                                                      AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)   ------------------------------------
 SPECIES                               INLET CONC   ----------------------              STD.        95% C.I.
  CODE        SPECIES                   (PPMV-C)      INLET      OUTLET        MEAN      DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------

  18       CYCLOHEXANONE                  1134         1106       84.3         92.38     0.279    ( 92.09, 92.67)


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RUN #    C-20      CATALYST INLET TEMP (DEG F)          598          SPACE VELOCITY                        49,576
MIXTURE            CATALYST OUTLET TEMP (DEG F)         623          RESIDENCE TIME (SECONDS)               0.023
                   CATALYST BED TEMP RISE (DEG F)        25          CATALYST BED PRESS DROP (" H2O)        1.0
                   MAIN HEATER TEMPERATURE (DEG F)

                                                      AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)   ------------------------------------
 SPECIES                               INLET CONC   ----------------------              STD.        95% C.I.
  CODE        SPECIES                   (PPMV-C)      INLET      OUTLET        MEAN      DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------

  24       DIOXANE                        1195         1239       82.3         93.34     0.357    ( 93.08, 93.60)


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RUN # C-21
MIXTURE 1

CATALYST INLET TEMP (DEG F)	598	SPACE VELOCITY	49,283
CATALYST OUTLET TEMP (DEG F)	625	RESIDENCE TIME (SECONDS)	0.023
CATALYST BED TEMP RISE (DEG F)	27	CATALYST BED PRESS DROP (" H2O)	1.0
MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	235	244	29.5	87.92	0.341	(87.56, 88.28)
2	METHYL ETHYL KETONE	234	250	20.5	91.81	0.238	(91.56, 92.06)
3	ETHYL ACETATE	235	251	29.2	88.37	0.318	(88.04, 88.71)
4	BENZENE	236	240	30.1	87.49	0.365	(87.11, 87.87)
5	N-HEXANE	234	242	67.3	72.29	0.830	(71.42, 73.16)
99	TOTAL HC	1174	1230	176.6	85.64	0.409	(85.21, 86.07)

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RUN # C-22
MIXTURE 5

CATALYST INLET TEMP (DEG F)	658	SPACE VELOCITY	19,948
CATALYST OUTLET TEMP (DEG F)	660	RESIDENCE TIME (SECONDS)	0.055
CATALYST BED TEMP RISE (DEG F)	2	CATALYST BED PRESS DROP (" H2O)	
MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	178	166	<2.0	>98.80	0.041	
26	ISOBUTYL ALDEHYDE	178	168	<2.0	>98.81	0.041	
27	N-BUTYL ALDEHYDE	178	170	<2.0	>98.83	0.039	
28	N-VALERALDEHYDE	178	167	<2.0	>98.81	0.041	
29	ISOVATERALDEHYDE	178	163	<2.0	>98.77	0.036	
99	TOTAL HC	890	836	10.0	98.80	0.038	(98.77, 98.83)

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RUN #    C-23      CATALYST INLET TEMP (DEG F)         698        SPACE VELOCITY                       29,922
MIXTURE  5         CATALYST OUTLET TEMP (DEG F)        717        RESIDENCE TIME (SECONDS)              0.035
                   CATALYST BED TEMP RISE (DEG F)       19        CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                    AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   ------------------------------------
SPECIES                               INLET CONC   ----------------------                STD.        95% C.I.
 CODE        SPECIES                  (PPMV-C)      INLET       OUTLET       MEAN        DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

  25      PROPIONALDEHYDE                 175         164          3.1        98.12     0.250    ( 97.86, 98.38)
  26      ISOBUTYL ALDEHYDE               176         167         <2.0       >98.80     0.067
  27      N-BUTYL ALDEHYDE                175         171         <2.0       >98.83     0.050
  28      N-VALERALDEHYDE                 176         162         <2.0       >98.77     0.082
  29      ISOVATERALDEHYDE                176         159         <2.0       >98.74     0.081

  99      TOTAL HC                        877         825         11.1        98.65     0.066    ( 98.58, 98.72)

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RUN #    C-24      CATALYST INLET TEMP (DEG F)         598        SPACE VELOCITY                       29,628
MIXTURE  5         CATALYST OUTLET TEMP (DEG F)        622        RESIDENCE TIME (SECONDS)              0.039
                   CATALYST BED TEMP RISE (DEG F)       24        CATALYST BED PRESS DROP (" H2O)
                   MAIN HEATER TEMPERATURE (DEG F)

                                                    AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)   ------------------------------------
SPECIES                               INLET CONC   ----------------------                STD.        95% C.I.
 CODE        SPECIES                  (PPMV-C)      INLET       OUTLET       MEAN        DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

  25      PROPIONALDEHYDE                 173         180          6.1        96.60     0.173    ( 96.44, 96.76)
  26      ISOBUTYL ALDEHYDE               173         182         <4.3       >97.65     0.229
  27      N-BUTYL ALDEHYDE                173         185         <4.0       >97.85     0.043
  28      N-VALERALDEHYDE                 173         179         <4.0       >97.76     0.076
  29      ISOVATERALDEHYDE                173         176         <4.0       >97.73     0.067

  99      TOTAL HC                        866         903         22.4        97.52     0.058    ( 97.47, 97.57)
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RUN #	C-25		
MIXTURE	5		
CATALYST INLET TEMP (DEG F)	698	SPACE VELOCITY	49,674
CATALYST OUTLET TEMP (DEG F)	723	RESIDENCE TIME (SECONDS)	0.021
CATALYST BED TEMP RISE (DEG F)	25	CATALYST BED PRESS DROP (" H2O)	1.0
MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	173	190	11.5	93.93	0.281	(93.64, 94.22)
26	ISOBUTYL ALDEHYDE	173	193	8.8	95.42	0.671	(94.71, 96.12)
27	N-BUTYL ALDEHYDE	173	194	5.8	97.03	0.527	(96.48, 97.59)
28	N-VALERALDEHYDE	173	191	<4.5	>97.65	0.249	
29	ISOVATERALDEHYDE	173	186	5.5	97.04	0.909	(96.09, 98.00)
99	TOTAL HC	866	956	36.2	96.21	0.288	(95.91, 96.52)

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RUN #	C-26		
MIXTURE	5		
CATALYST INLET TEMP (DEG F)	789	SPACE VELOCITY	49,478
CATALYST OUTLET TEMP (DEG F)	816	RESIDENCE TIME (SECONDS)	0.020
CATALYST BED TEMP RISE (DEG F)	27	CATALYST BED PRESS DROP (" H2O)	
MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	176	180	7.6	95.76	0.312	(95.44, 96.09)
26	ISOBUTYL ALDEHYDE	176	182	6.1	96.67	0.474	(96.17, 97.17)
27	N-BUTYL ALDEHYDE	176	186	<4.3	>97.68	0.462	
28	N-VALERALDEHYDE	176	182	<4.0	>97.80	0.100	
29	ISOVATERALDEHYDE	176	177	<4.0	>97.75	0.080	
99	TOTAL HC	881	909	26.0	97.13	0.211	(96.91, 97.36)

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RUN #    C-27     CATALYST INLET TEMP (DEG F)          598          SPACE VELOCITY                        49,381
MIXTURE  5        CATALYST OUTLET TEMP (DEG F)         632          RESIDENCE TIME (SECONDS)               0.023
                  CATALYST BED TEMP RISE (DEG F)        34          CATALYST BED PRESS DROP (" H2O)          1.0
                  MAIN HEATER TEMPERATURE (DEG F)

                                                         AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                           CALCULATED   CONCENTRATION (PPMV-C)     ----------------------------------
SPECIES                                    INLET CONC   ----------------------                STD.       95% C.I.
 CODE        SPECIES                       (PPMV-C)       INLET      OUTLET         MEAN      DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------
  25       PROPIONALDEHYDE                   175           179        18.2          89.88     0.281    ( 89.58, 90.17)
  26       ISOBUTYL ALDEHYDE                 175           179        11.8          93.41     0.368    ( 93.03, 93.80)
  27       N-BUTYL ALDEHYDE                  175           182        11.3          93.81     0.602    ( 93.18, 94.44)
  28       N-VALERALDEHYDE                   175           179        11.6          93.55     0.998    ( 92.50, 94.59)
  29       ISOVATERALDEHYDE                  175           176        12.0          93.20     0.630    ( 92.54, 93.87)

  99       TOTAL HC                          874           898        64.9          92.77     0.292    ( 92.47, 93.08)


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RUN #    C-28     CATALYST INLET TEMP (DEG F)          598          SPACE VELOCITY                        49,870
MIXTURE           CATALYST OUTLET TEMP (DEG F)         626          RESIDENCE TIME (SECONDS)               0.023
                  CATALYST BED TEMP RISE (DEG F)        28          CATALYST BED PRESS DROP (" H2O)          1.0
                  MAIN HEATER TEMPERATURE (DEG F)

                                                         AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                           CALCULATED   CONCENTRATION (PPMV-C)     ----------------------------------
SPECIES                                    INLET CONC   ----------------------                STD.       95% C.I.
 CODE        SPECIES                       (PPMV-C)       INLET      OUTLET         MEAN      DEV.      ON THE MEAN
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  25       PROPIONALDEHYDE                  1197          1215        62.9          94.83     0.129    ( 94.69, 94.96)


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RUN #	C-29	CATALYST INLET TEMP (DEG F)	598	SPACE VELOCITY	20,046
MIXTURE	5	CATALYST OUTLET TEMP (DEG F)	616	RESIDENCE TIME (SECONDS)	0.057
		CATALYST BED TEMP RISE (DEG F)	18	CATALYST BED PRESS DROP (" H2O)	0.5
		MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	180	180	<2.0	>98.89	0.038	
26	ISOBUTYL ALDEHYDE	180	178	<2.0	>98.87	0.048	
27	N-BUTYL ALDEHYDE	180	180	<2.0	>98.89	0.029	
28	N-VALERALDEHYDE	180	180	<4.0	>97.78	0.051	
29	ISOVATERALDEHYDE	180	176	<4.0	>97.73	0.065	
99	TOTAL HC	901	895	14.0	98.44	0.047	(98.39, 98.49)

RUN #	C-30	CATALYST INLET TEMP (DEG F)	648	SPACE VELOCITY	29,824
MIXTURE	5	CATALYST OUTLET TEMP (DEG F)	671	RESIDENCE TIME (SECONDS)	0.037
		CATALYST BED TEMP RISE (DEG F)	23	CATALYST BED PRESS DROP (" H2O)	
		MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	180	185	5.1	97.25	0.119	(97.12, 97.37)
26	ISOBUTYL ALDEHYDE	181	181	<4.0	>97.80	0.087	
27	N-BUTYL ALDEHYDE	180	186	<4.0	>97.85	0.064	
28	N-VALERALDEHYDE	181	181	<4.0	>97.79	0.091	
29	ISOVATERALDEHYDE	181	179	<4.0	>97.77	0.073	
99	TOTAL HC	903	914	21.1	97.69	0.072	(97.61, 97.77)

RUN #	C-31	CATALYST INLET TEMP (DEG F)	649	SPACE VELOCITY	49,576
MIXTURE	5	CATALYST OUTLET TEMP (DEG F)	679	RESIDENCE TIME (SECONDS)	0.022
		CATALYST BED TEMP RISE (DEG F)	30	CATALYST BED PRESS DROP (" H2O)	1.0
		MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	179	201	17.2	91.46	1.022	(90.39, 92.53)
26	ISOBUTYL ALDEHYDE	179	198	11.9	94.02	1.294	(92.66, 95.38)
27	N-BUTYL ALDEHYDE	179	201	9.1	95.49	0.412	(95.05, 95.92)
28	N-VALERALDEHYDE	179	201	10.5	94.78	0.940	(93.79, 95.77)
29	ISOVATERALDEHYDE	179	196	12.1	93.82	1.061	(92.71, 94.94)
99	TOTAL HC	896	999	60.8	93.91	0.685	(93.19, 94.63)

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RUN #	C-32	CATALYST INLET TEMP (DEG F)	648	SPACE VELOCITY	20,143
MIXTURE	6	CATALYST OUTLET TEMP (DEG F)	665	RESIDENCE TIME (SECONDS)	0.055
		CATALYST BED TEMP RISE (DEG F)	17	CATALYST BED PRESS DROP (" H2O)	
		MAIN HEATER TEMPERATURE (DEG F)			

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	167	174	5.0	97.13	0.108	(97.01, 97.24)
5	N-HEXANE	167	135	<2.0	>98.52	0.061	
8	TOLUENE	167	173	2.7	98.43	0.384	(98.03, 98.83)
31	N-OCTANE	168	154	<2.0	>98.70	0.050	
32	N-DECANE	167	170	<2.0	>98.83	0.038	
33	P-XYLENE	167	174	<2.0	>98.85	0.037	
34	ISOPROPYL BENZENE	167	172	<2.0	>98.84	0.035	
99	TOTAL HC	1170	1155	17.7	98.46	0.094	(98.37, 98.56)

RUN # C-33
MIXTURE 6

CATALYST INLET TEMP (DEG F) 698
CATALYST OUTLET TEMP (DEG F) 724
CATALYST BED TEMP RISE (DEG F) 26
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 29,922
RESIDENCE TIME (SECONDS) 0.035
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	165	173	10.6	93.87	0.583	(93.26, 94.48)
5	N-HEXANE	165	136	10.8	92.06	0.246	(91.80, 92.32)
8	TOLUENE	165	173	9.5	94.50	0.944	(93.51, 95.49)
31	N-OCTANE	166	154	4.9	96.81	0.190	(96.61, 97.01)
32	N-DECANE	165	169	3.8	97.79	0.278	(97.50, 98.08)
33	P-XYLENE	165	173	7.6	95.64	1.117	(94.46, 96.81)
34	ISOPROPYL BENZENE	165	171	10.0	94.18	2.096	(91.98, 96.38)
99	TOTAL HC	1156	1151	57.1	95.04	0.645	(94.36, 95.71)

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RUN # C-34
MIXTURE 6

CATALYST INLET TEMP (DEG F) 599
CATALYST OUTLET TEMP (DEG F) 622
CATALYST BED TEMP RISE (DEG F) 23
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 19,850
RESIDENCE TIME (SECONDS) 0.058
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	166	172	4.8	97.23	0.149	(97.07, 97.38)
5	N-HEXANE	166	165	6.7	95.97	0.370	(95.58, 96.35)
8	TOLUENE	166	172	4.4	97.45	0.365	(97.07, 97.84)
31	N-OCTANE	167	170	<2.1	>98.78	0.068	
32	N-DECANE	167	173	<2.0	>98.84	0.020	
33	P-XYLENE	166	174	3.4	98.06	0.630	(97.40, 98.72)
34	ISOPROPYL BENZENE	167	175	4.0	97.72	0.368	(97.33, 98.10)
99	TOTAL HC	1166	1203	27.3	97.73	0.187	(97.53, 97.93)

RUN # C-35
MIXTURE 6

CATALYST INLET TEMP (DEG F) 648
CATALYST OUTLET TEMP (DEG F) 675
CATALYST BED TEMP RISE (DEG F) 27
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 29,824
RESIDENCE TIME (SECONDS) 0.037
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	166	172	9.6	94.43	0.315	(94.14, 94.73)
5	N-HEXANE	166	165	13.1	92.07	0.269	(91.82, 92.32)
8	TOLUENE	165	171	8.4	95.13	0.335	(94.82, 95.44)
31	N-OCTANE	167	170	7.9	95.37	0.234	(95.15, 95.59)
32	N-DECANE	166	172	5.4	96.88	0.265	(96.63, 97.12)
33	P-XYLENE	166	173	6.7	96.14	0.306	(95.85, 96.42)
34	ISOPROPYL BENZENE	166	174	8.3	95.24	0.294	(94.97, 95.52)
99	TOTAL HC	1161	1200	59.3	95.06	0.115	(94.95, 95.16)

RUN # C-36
MIXTURE 6

CATALYST INLET TEMP (DEG F) 798
CATALYST OUTLET TEMP (DEG F) 823
CATALYST BED TEMP RISE (DEG F) 25
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 49,381
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	163	159	16.9	89.38	0.351	(89.01, 89.75)
5	N-HEXANE	163	161	15.3	90.47	0.249	(90.20, 90.73)
8	TOLUENE	163	158	11.7	92.63	0.445	(92.17, 93.10)
31	N-OCTANE	164	159	9.1	94.29	0.291	(93.98, 94.59)
32	N-DECANE	163	159	6.3	96.02	0.279	(95.72, 96.31)
33	P-XYLENE	163	160	8.2	94.90	0.171	(94.72, 95.08)
34	ISOPROPYL BENZENE	164	160	10.2	93.62	0.258	(93.35, 93.89)
99	TOTAL HC	1144	1118	77.7	93.04	0.212	(92.82, 93.26)

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RUN #     C-37        CATALYST INLET TEMP (DEG F)          598          SPACE VELOCITY                       49,674
MIXTURE   6           CATALYST OUTLET TEMP (DEG F)         626          RESIDENCE TIME (SECONDS)              0.023
                      CATALYST BED TEMP RISE (DEG F)        28          CATALYST BED PRESS DROP (" H2O)         1.0
                      MAIN HEATER TEMPERATURE (DEG F)

                                                          AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                          CALCULATED    CONCENTRATION (PPMV-C)    ------------------------------------
SPECIES                                   INLET CONC    ----------------------                STD.        95% C.I.
 CODE        SPECIES                       (PPMV-C)        INLET     OUTLET         MEAN      DEV.      ON THE MEAN
--------------------------------------------------------------------------------------------------------------------

   4        BENZENE                          163            167       18.3          89.02     0.740    ( 88.33, 89.70)
   5        N-HEXANE                         163            174       24.4          85.96     0.901    ( 85.13, 86.79)
   8        TOLUENE                          163            167       19.7          88.23     0.618    ( 87.66, 88.80)
  31        N-OCTANE                         164            165       13.3          91.99     0.538    ( 91.49, 92.48)
  32        N-DECANE                         163            165       11.2          93.22     0.525    ( 92.73, 93.70)
  33        P-XYLENE                         163            168       18.3          89.13     1.065    ( 88.15, 90.12)
  34        ISOPROPYL BENZENE                163            169       20.4          87.94     0.879    ( 87.12, 88.75)

  99        TOTAL HC                        1142           1177      125.6          89.32     0.734    ( 88.64, 90.00)


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RUN #     C-38        CATALYST INLET TEMP (DEG F)          598          SPACE VELOCITY                       49,870
MIXTURE               CATALYST OUTLET TEMP (DEG F)         623          RESIDENCE TIME (SECONDS)              0.023
                      CATALYST BED TEMP RISE (DEG F)        25          CATALYST BED PRESS DROP (" H2O)
                      MAIN HEATER TEMPERATURE (DEG F)

                                                          AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                          CALCULATED    CONCENTRATION (PPMV-C)    ------------------------------------
SPECIES                                   INLET CONC    ----------------------                STD.        95% C.I.
 CODE        SPECIES                       (PPMV-C)        INLET     OUTLET         MEAN      DEV.      ON THE MEAN
--------------------------------------------------------------------------------------------------------------------

  32        N-DECANE                        1184           1278       27.6          97.84     0.105    ( 97.73, 97.95)
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RUN #     C-39        CATALYST INLET TEMP (DEG F)          598          SPACE VELOCITY                       49,381
MIXTURE               CATALYST OUTLET TEMP (DEG F)         628          RESIDENCE TIME (SECONDS)              0.023
                      CATALYST BED TEMP RISE (DEG F)        30          CATALYST BED PRESS DROP (" H2O)         1.0
                      MAIN HEATER TEMPERATURE (DEG F)

                                                       AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                         CALCULATED  CONCENTRATION (PPMV-C)     -----------------------------------
SPECIES                                  INLET CONC  ----------------------                STD.        95% C.I.
 CODE        SPECIES                      (PPMV-C)      INLET      OUTLET          MEAN    DEV.      ON THE MEAN
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  34       ISOPROPYL BENZENE                1210         1123       181.8          83.80   0.702    ( 83.07, 84.54)


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RUN #     C-40        CATALYST INLET TEMP (DEG F)          648          SPACE VELOCITY                       48,892
MIXTURE   6           CATALYST OUTLET TEMP (DEG F)         675          RESIDENCE TIME (SECONDS)              0.023
                      CATALYST BED TEMP RISE (DEG F)        27          CATALYST BED PRESS DROP (" H2O)         1.0
                      MAIN HEATER TEMPERATURE (DEG F)

                                                       AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                         CALCULATED  CONCENTRATION (PPMV-C)     -----------------------------------
SPECIES                                  INLET CONC  ----------------------                STD.        95% C.I.
 CODE        SPECIES                      (PPMV-C)      INLET      OUTLET          MEAN    DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------

   4       BENZENE                           164          165        17.1          89.63   0.590    ( 89.09, 90.18)
   5       N-HEXANE                          164          171        21.8          87.31   0.547    ( 86.81, 87.82)
   8       TOLUENE                           164          165        17.3          89.56   0.428    ( 89.17, 89.96)
  31       N-OCTANE                          165          163        13.3          91.89   0.423    ( 91.49, 92.28)
  32       N-DECANE                          164          164        11.5          92.96   0.398    ( 92.59, 93.33)
  33       P-XYLENE                          164          167        16.6          90.06   1.015    ( 89.12, 91.00)
  34       ISOPROPYL BENZENE                 164          168        18.7          88.88   0.728    ( 88.21, 89.55)

  99       TOTAL HC                         1148         1166       116.3          90.01   0.526    ( 89.53, 90.50)
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```
RUN #    C-41       CATALYST INLET TEMP (DEG F)         598          SPACE VELOCITY                          49,381
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)        626          RESIDENCE TIME (SECONDS)                 0.023
                    CATALYST BED TEMP RISE (DEG F)       28          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                  AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                   CALCULATED   CONCENTRATION (PPMV-C)     ----------------------------------
SPECIES                            INLET CONC   ----------------------              STD.        95% C.I.
 CODE        SPECIES               (PPMV-C)       INLET      OUTLET          MEAN     DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

  1        ISOPROPANOL                243           255        32.5          87.28    1.443    ( 85.95, 88.62)
  2        METHYL ETHYL KETONE        242           265        23.4          91.19    0.207    ( 91.00, 91.38)
  3        ETHYL ACETATE              243           265        31.9          87.98    0.245    ( 87.76, 88.21)
  4        BENZENE                    244           255        26.9          89.46    0.246    ( 89.23, 89.69)
  5        N-HEXANE                   241           262        65.8          74.94    0.479    ( 74.50, 75.38)

 99        TOTAL HC                  1213          1304       180.5          86.17    0.345    ( 85.85, 86.48)


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RUN #    C-42       CATALYST INLET TEMP (DEG F)         598          SPACE VELOCITY                          20,143
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)        619          RESIDENCE TIME (SECONDS)                 0.057
                    CATALYST BED TEMP RISE (DEG F)       21          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)

                                                  AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                   CALCULATED   CONCENTRATION (PPMV-C)     ----------------------------------
SPECIES                            INLET CONC   ----------------------              STD.        95% C.I.
 CODE        SPECIES               (PPMV-C)       INLET      OUTLET          MEAN     DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

  1        ISOPROPANOL                244           272         2.8          98.97    0.076    ( 98.90, 99.04)
  2        METHYL ETHYL KETONE        243           282        <2.0         >99.29    0.024
  3        ETHYL ACETATE              243           281        <2.0         >99.29    0.024
  4        BENZENE                    245           272         6.7          97.54    0.086    ( 97.46, 97.62)
  5        N-HEXANE                   242           276        17.5          93.66    1.003    ( 92.73, 94.58)

 99        TOTAL HC                  1217          1383        31.0          97.76    0.227    ( 97.55, 97.97)
```

```
RUN #     C-43      CATALYST INLET TEMP (DEG F)           645           SPACE VELOCITY                          30,117
MIXTURE   1         CATALYST OUTLET TEMP (DEG F)          670           RESIDENCE TIME (SECONDS)                 0.037
                    CATALYST BED TEMP RISE (DEG F)         25           CATALYST BED PRESS DROP (" H2O)            0.6
                    MAIN HEATER TEMPERATURE (DEG F)      1080

                                                           AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                          CALCULATED    CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                   INLET CONC    ----------------------                 STD.       95% C.I.
 CODE         SPECIES                      (PPMV-C)       INLET      OUTLET         MEAN       DEV.     ON THE MEAN
------------------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                      241           263         7.6          97.11      0.246   ( 96.86, 97.37)
   2        METHYL ETHYL KETONE              240           271         5.6          97.94      0.069   ( 97.87, 98.01)
   3        ETHYL ACETATE                    240           262         4.1          98.45      0.057   ( 98.39, 98.51)
   4        BENZENE                          241           261        14.6          94.43      0.098   ( 94.33, 94.53)
   5        N-HEXANE                         239           259        33.4          87.15      0.274   ( 86.86, 87.44)

  99        TOTAL HC                        1201          1319        65.3          95.06      0.139   ( 94.91, 95.20)


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RUN #     C-43H     CATALYST INLET TEMP (DEG F)           645           SPACE VELOCITY                          30,117
MIXTURE   1         CATALYST OUTLET TEMP (DEG F)          670           RESIDENCE TIME (SECONDS)                 0.037
                    CATALYST BED TEMP RISE (DEG F)         25           CATALYST BED PRESS DROP (" H2O)            0.6
                    MAIN HEATER TEMPERATURE (DEG F)      1080

                                                           AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                          CALCULATED    CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                   INLET CONC    ----------------------                 STD.       95% C.I.
 CODE         SPECIES                      (PPMV-C)       INLET      OUTLET         MEAN       DEV.     ON THE MEAN
------------------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                      241           266       102.9          61.29      1.455   ( 59.81, 62.77)
   2        METHYL ETHYL KETONE              240           282        77.0          72.70      1.115   ( 71.56, 73.83)
   3        ETHYL ACETATE                    240           264        40.5          84.69      0.855   ( 83.82, 85.56)
   4        BENZENE                          241           265       248.2           6.40      4.685   (  1.62, 11.17)
   5        N-HEXANE                         239           262       231.6          11.67      3.667   (  7.94, 15.41)

  99        TOTAL HC                        1201          1341       700.2          47.75      1.877   ( 45.83, 49.66)
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RUN #     C-44        CATALYST INLET TEMP (DEG F)          648          SPACE VELOCITY                         20,143
MIXTURE   1           CATALYST OUTLET TEMP (DEG F)         664          RESIDENCE TIME (SECONDS)                0.055
                      CATALYST BED TEMP RISE (DEG F)        16          CATALYST BED PRESS DROP (" H2O)           0.4
                      MAIN HEATER TEMPERATURE (DEG F)     1245

                                                         AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)     ------------------------------------
 SPECIES                                 INLET CONC   ----------------------              STD.        95% C.I.
  CODE       SPECIES                      (PPMV-C)      INLET      OUTLET          MEAN     DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                     241          265        <2.0          >99.25   0.027
   2        METHYL ETHYL KETONE             241          276        <2.0          >99.28   0.034
   3        ETHYL ACETATE                   241          262        <2.0          >99.24   0.025
   4        BENZENE                         242          260         3.7           98.59   0.143    ( 98.45, 98.72)
   5        N-HEXANE                        240          263        <2.0          >99.24   0.032

  99        TOTAL HC                       1205         1328        11.7           99.12   0.048    ( 99.08, 99.16)


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RUN #     C-44H       CATALYST INLET TEMP (DEG F)          648          SPACE VELOCITY                         20,143
MIXTURE   1           CATALYST OUTLET TEMP (DEG F)         664          RESIDENCE TIME (SECONDS)                0.055
                      CATALYST BED TEMP RISE (DEG F)        16          CATALYST BED PRESS DROP (" H2O)           0.4
                      MAIN HEATER TEMPERATURE (DEG F)     1245

                                                         AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)     ------------------------------------
 SPECIES                                 INLET CONC   ----------------------              STD.        95% C.I.
  CODE       SPECIES                      (PPMV-C)      INLET      OUTLET          MEAN     DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                     241          249        39.7           84.02   1.007    ( 83.00, 85.05)
   2        METHYL ETHYL KETONE             241          265        15.6           94.13   0.283    ( 93.84, 94.42)
   3        ETHYL ACETATE                   241          249        <2.0          >99.20   0.034
   4        BENZENE                         242          251       112.2           55.32   2.127    ( 53.16, 57.49)
   5        N-HEXANE                        240          254        <2.4          >99.07   0.306

  99        TOTAL HC                       1205         1270       171.9           86.46   0.592    ( 85.86, 87.06)
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RUN #     C-45      CATALYST INLET TEMP (DEG F)          698          SPACE VELOCITY                     29,971
MIXTURE   1         CATALYST OUTLET TEMP (DEG F)         722          RESIDENCE TIME (SECONDS)            0.035
                    CATALYST BED TEMP RISE (DEG F)        24          CATALYST BED PRESS DROP (" H2O)       0.6
                    MAIN HEATER TEMPERATURE (DEG F)     1258

                                                  AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                    CALCULATED  CONCENTRATION (PPMV-C)   -----------------------------------
SPECIES                             INLET CONC  ----------------------               STD.        95% C.I.
 CODE      SPECIES                   (PPMV-C)      INLET     OUTLET         MEAN     DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

   1      ISOPROPANOL                  243          249        5.8         97.67    0.394    ( 97.26, 98.09)
   2      METHYL ETHYL KETONE          242          260        4.4         98.33    0.190    ( 98.13, 98.52)
   3      ETHYL ACETATE                243          252       <2.0        >99.19    0.040
   4      BENZENE                      244          251       13.7         94.55    0.092    ( 94.45, 94.64)
   5      N-HEXANE                     241          249       25.3         89.87    0.465    ( 89.39, 90.36)

  99      TOTAL HC                    1214         1262       51.2         95.95    0.125    ( 95.82, 96.08)


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RUN #     C-45H     CATALYST INLET TEMP (DEG F)          698          SPACE VELOCITY                     29,971
MIXTURE   1         CATALYST OUTLET TEMP (DEG F)         722          RESIDENCE TIME (SECONDS)            0.035
                    CATALYST BED TEMP RISE (DEG F)        24          CATALYST BED PRESS DROP (" H2O)       0.6
                    MAIN HEATER TEMPERATURE (DEG F)     1258

                                                  AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                    CALCULATED  CONCENTRATION (PPMV-C)   -----------------------------------
SPECIES                             INLET CONC  ----------------------               STD.        95% C.I.
 CODE      SPECIES                   (PPMV-C)      INLET     OUTLET         MEAN     DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

   1      ISOPROPANOL                  243          261       95.9         63.31    0.904    ( 61.07, 65.56)
   2      METHYL ETHYL KETONE          242          271       67.0         75.31    0.650    ( 73.70, 76.93)
   3      ETHYL ACETATE                243          260        5.9         97.75    0.138    ( 97.41, 98.09)
   4      BENZENE                      244          259      240.7          7.17    3.448    ( -1.39, 15.73)
   5      N-HEXANE                     241          258      175.3         31.98    2.184    ( 26.56, 37.40)

  99      TOTAL HC                    1214         1310      584.7         55.37    1.210    ( 52.37, 58.38)
```

RUN # C-46
MIXTURE 1

CATALYST INLET TEMP (DEG F) 798
CATALYST OUTLET TEMP (DEG F) 818
CATALYST BED TEMP RISE (DEG F) 20
MAIN HEATER TEMPERATURE (DEG F) 1250

SPACE VELOCITY 48,990
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O) 1.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	243	255	10.5	95.89	0.310	(95.60, 96.17)
2	METHYL ETHYL KETONE	242	266	8.2	96.93	0.207	(96.74, 97.12)
3	ETHYL ACETATE	243	257	1.8	99.31	0.050	(99.26, 99.36)
4	BENZENE	244	256	22.8	91.09	0.671	(90.47, 91.71)
5	N-HEXANE	241	258	32.5	87.37	0.993	(86.46, 88.29)
99	TOTAL HC	1212	1295	75.7	94.14	0.423	(93.75, 94.53)

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RUN # C-46H
MIXTURE 1

CATALYST INLET TEMP (DEG F) 798
CATALYST OUTLET TEMP (DEG F) 818
CATALYST BED TEMP RISE (DEG F) 20
MAIN HEATER TEMPERATURE (DEG F) 1250

SPACE VELOCITY 48,990
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O) 1.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	243	249	116.2	53.37	1.220	(52.09, 54.65)
2	METHYL ETHYL KETONE	242	263	91.5	65.23	0.809	(64.38, 66.08)
3	ETHYL ACETATE	243	254	22.6	91.09	0.424	(90.65, 91.54)
4	BENZENE	244	252	238.2	5.63	2.344	(3.17, 8.09)
5	N-HEXANE	241	253	205.3	18.95	2.761	(16.05, 21.85)
99	TOTAL HC	1212	1272	673.8	47.02	1.341	(45.62, 48.43)

RUN # C-47
MIXTURE 1

CATALYST INLET TEMP (DEG F)	602	SPACE VELOCITY	19,557
CATALYST OUTLET TEMP (DEG F)	619	RESIDENCE TIME (SECONDS)	0.059
CATALYST BED TEMP RISE (DEG F)	17	CATALYST BED PRESS DROP (" H2O)	0.2
MAIN HEATER TEMPERATURE (DEG F)	1110		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	229	260	<2.0	>99.23	0.020	
2	METHYL ETHYL KETONE	229	257	<2.0	>99.22	0.020	
3	ETHYL ACETATE	229	259	<2.0	>99.23	0.031	
4	BENZENE	230	249	6.0	97.58	0.092	(97.48, 97.67)
5	N-HEXANE	228	247	18.4	92.54	0.524	(91.99, 93.09)
99	TOTAL HC	1145	1273	30.4	97.61	0.111	(97.49, 97.72)

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RUN # C-47H
MIXTURE 1

CATALYST INLET TEMP (DEG F)	602	SPACE VELOCITY	19,557
CATALYST OUTLET TEMP (DEG F)	619	RESIDENCE TIME (SECONDS)	0.059
CATALYST BED TEMP RISE (DEG F)	17	CATALYST BED PRESS DROP (" H2O)	0.2
MAIN HEATER TEMPERATURE (DEG F)	1110		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	229	259	76.7	70.46	1.529	(69.05, 71.87)
2	METHYL ETHYL KETONE	229	260	46.4	82.21	0.846	(81.42, 82.99)
3	ETHYL ACETATE	229	262	<2.0	>99.23	0.047	
4	BENZENE	230	251	232.0	7.92	3.164	(4.99, 10.85)
5	N-HEXANE	228	251	163.0	35.09	1.828	(33.40, 36.78)
99	TOTAL HC	1145	1285	520.1	59.54	1.416	(58.24, 60.85)

RUN #	C-48	CATALYST INLET TEMP (DEG F)	595	SPACE VELOCITY	30,020
MIXTURE	1	CATALYST OUTLET TEMP (DEG F)	620	RESIDENCE TIME (SECONDS)	0.038
		CATALYST BED TEMP RISE (DEG F)	25	CATALYST BED PRESS DROP (" H2O)	0.5
		MAIN HEATER TEMPERATURE (DEG F)	1025		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	239	251	9.9	96.04	0.123	(95.91, 96.17)
2	METHYL ETHYL KETONE	238	253	6.0	97.64	0.070	(97.57, 97.71)
3	ETHYL ACETATE	239	256	8.6	96.65	0.131	(96.51, 96.78)
4	BENZENE	240	244	13.3	94.55	0.225	(94.31, 94.79)
5	N-HEXANE	237	242	37.6	84.50	0.652	(83.81, 85.18)
99	TOTAL HC	1193	1248	75.4	93.95	0.231	(93.71, 94.19)

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RUN #	C-48H	CATALYST INLET TEMP (DEG F)	595	SPACE VELOCITY	30,020
MIXTURE	1	CATALYST OUTLET TEMP (DEG F)	620	RESIDENCE TIME (SECONDS)	0.038
		CATALYST BED TEMP RISE (DEG F)	25	CATALYST BED PRESS DROP (" H2O)	0.5
		MAIN HEATER TEMPERATURE (DEG F)	1025		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	239	247	117.8	52.30	1.065	(51.18, 53.42)
2	METHYL ETHYL KETONE	238	251	83.0	66.90	0.679	(66.19, 67.62)
3	ETHYL ACETATE	239	253	94.3	62.76	0.765	(61.96, 63.56)
4	BENZENE	240	241	227.2	6.03	2.033	(3.90, 8.17)
5	N-HEXANE	237	242	222.0	8.37	2.340	(5.92, 10.83)
99	TOTAL HC	1193	1235	744.4	39.74	1.213	(38.47, 41.02)

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RUN #     C-49        CATALYST INLET TEMP (DEG F)         598         SPACE VELOCITY                        49,674
MIXTURE   1           CATALYST OUTLET TEMP (DEG F)        624         RESIDENCE TIME (SECONDS)               0.023
                      CATALYST BED TEMP RISE (DEG F)       26         CATALYST BED PRESS DROP (" H2O)          1.0
                      MAIN HEATER TEMPERATURE (DEG F)     921

                                                       AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                        CALCULATED   CONCENTRATION (PPMV-C)     ----------------------------------
 SPECIES                                INLET CONC   ----------------------                STD.        95% C.I.
  CODE       SPECIES                     (PPMV-C)      INLET      OUTLET          MEAN     DEV.      ON THE MEAN
------------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                    237           256        32.5          87.32    0.451    ( 86.90, 87.74)
   2        METHYL ETHYL KETONE            236           258        22.9          91.18    0.390    ( 90.82, 91.54)
   3        ETHYL ACETATE                  237           263        31.7          88.02    0.538    ( 87.52, 88.52)
   4        BENZENE                        238           249        26.8          89.26    0.328    ( 88.96, 89.56)
   5        N-HEXANE                       235           244        63.0          74.31    0.467    ( 73.88, 74.74)

  99        TOTAL HC                      1184          1273       176.9          86.13    0.431    ( 85.73, 86.53)


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RUN #     C-49H       CATALYST INLET TEMP (DEG F)         598         SPACE VELOCITY                        49,674
MIXTURE   1           CATALYST OUTLET TEMP (DEG F)        624         RESIDENCE TIME (SECONDS)               0.023
                      CATALYST BED TEMP RISE (DEG F)       26         CATALYST BED PRESS DROP (" H2O)          1.0
                      MAIN HEATER TEMPERATURE (DEG F)     921

                                                       AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                        CALCULATED   CONCENTRATION (PPMV-C)     ----------------------------------
 SPECIES                                INLET CONC   ----------------------                STD.        95% C.I.
  CODE       SPECIES                     (PPMV-C)      INLET      OUTLET          MEAN     DEV.      ON THE MEAN
------------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                    237           244       182.3          25.34    3.634    ( 21.98, 28.70)
   2        METHYL ETHYL KETONE            236           252       146.0          41.94    3.368    ( 38.83, 45.06)
   3        ETHYL ACETATE                  237           250       170.6          31.85    3.783    ( 28.36, 35.35)
   4        BENZENE                        238           239       219.6           7.96    5.030    (  3.31, 12.61)
   5        N-HEXANE                       235           236       215.6           8.74    5.221    (  3.91, 13.57)

  99        TOTAL HC                      1184          1223       934.0          23.50    4.021    ( 19.78, 27.22)
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RUN #     C-50       CATALYST INLET TEMP (DEG F)          698          SPACE VELOCITY                       50,163
MIXTURE   1          CATALYST OUTLET TEMP (DEG F)         724          RESIDENCE TIME (SECONDS)              0.021
                     CATALYST BED TEMP RISE (DEG F)        26          CATALYST BED PRESS DROP (" H2O)         1.3
                     MAIN HEATER TEMPERATURE (DEG F)     1065

                                                           AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                          CALCULATED    CONCENTRATION (PPMV-C)     ----------------------------------
 SPECIES                                  INLET CONC    ----------------------                STD.        95% C.I.
  CODE        SPECIES                      (PPMV-C)       INLET      OUTLET         MEAN      DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                      237            252        16.9          93.32     0.173    ( 93.14, 93.51)
   2        METHYL ETHYL KETONE              237            258        12.4          95.19     0.145    ( 95.04, 95.34)
   3        ETHYL ACETATE                    237            259        15.5          94.04     0.265    ( 93.76, 94.32)
   4        BENZENE                          238            246        23.8          90.32     0.168    ( 90.15, 90.50)
   5        N-HEXANE                         236            245        47.5          80.63     0.395    ( 80.22, 81.04)

  99        TOTAL HC                        1185           1261       116.1          90.80     0.182    ( 90.61, 90.99)


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RUN #     C-50H      CATALYST INLET TEMP (DEG F)          698          SPACE VELOCITY                       50,163
MIXTURE   1          CATALYST OUTLET TEMP (DEG F)         724          RESIDENCE TIME (SECONDS)              0.021
                     CATALYST BED TEMP RISE (DEG F)        26          CATALYST BED PRESS DROP (" H2O)         1.3
                     MAIN HEATER TEMPERATURE (DEG F)     1065

                                                           AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                          CALCULATED    CONCENTRATION (PPMV-C)     ----------------------------------
 SPECIES                                  INLET CONC    ----------------------                STD.        95% C.I.
  CODE        SPECIES                      (PPMV-C)       INLET      OUTLET         MEAN      DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------------

   1        ISOPROPANOL                      237            248       144.0          42.01     0.991    ( 40.97, 43.05)
   2        METHYL ETHYL KETONE              237            252       111.5          55.75     0.690    ( 55.03, 56.48)
   3        ETHYL ACETATE                    237            253       126.7          50.06     0.998    ( 49.02, 51.11)
   4        BENZENE                          238            240       231.7           3.81     1.483    (  2.25,  5.36)
   5        N-HEXANE                         236            239       227.8           4.68     1.570    (  3.03,  6.32)

  99        TOTAL HC                        1185           1233       841.7          31.78     1.069    ( 30.66, 32.91)
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RUN #    C-51       CATALYST INLET TEMP (DEG F)         598          SPACE VELOCITY                         49,478
MIXTURE  3          CATALYST OUTLET TEMP (DEG F)        627          RESIDENCE TIME (SECONDS)                0.023
                    CATALYST BED TEMP RISE (DEG F)       29          CATALYST BED PRESS DROP (" H2O)           1.0
                    MAIN HEATER TEMPERATURE (DEG F)     937

                                                         AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                           CALCULATED   CONCENTRATION (PPMV-C)     ------------------------------------
SPECIES                                    INLET CONC   ----------------------               STD.          95% C.I.
 CODE        SPECIES                        (PPMV-C)      INLET     OUTLET         MEAN      DEV.        ON THE MEAN
---------------------------------------------------------------------------------------------------------------------

   1       ISOPROPANOL                        177          181       27.9          84.28     2.860     ( 81.28, 87.28)
   3       ETHYL ACETATE                      176          197       29.2          84.58     4.077     ( 80.30, 88.86)
   9       METHANOL                           176          166        5.4          96.63     0.981     ( 95.60, 97.66)
  10       ETHANOL                            177          191        7.3          96.06     1.066     ( 94.94, 97.18)
  12       N-BUTANOL                          177          200        8.8          95.44     1.190     ( 94.19, 96.69)
  14       N-PROPYL ACETATE                   177          188       25.3          86.23     2.917     ( 83.17, 89.29)
  15       ISOBUTYL ACETATE                   176          189       25.8          86.24     2.838     ( 83.26, 89.22)

  99       TOTAL HC                          1236         1315      129.8          89.88     2.092     ( 87.68, 92.08)


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RUN #    C-51H      CATALYST INLET TEMP (DEG F)         598          SPACE VELOCITY                         49,478
MIXTURE  3          CATALYST OUTLET TEMP (DEG F)        627          RESIDENCE TIME (SECONDS)                0.023
                    CATALYST BED TEMP RISE (DEG F)       29          CATALYST BED PRESS DROP (" H2O)           1.0
                    MAIN HEATER TEMPERATURE (DEG F)     937

                                                         AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                           CALCULATED   CONCENTRATION (PPMV-C)     ------------------------------------
SPECIES                                    INLET CONC   ----------------------               STD.          95% C.I.
 CODE        SPECIES                        (PPMV-C)      INLET     OUTLET         MEAN      DEV.        ON THE MEAN
---------------------------------------------------------------------------------------------------------------------

   1       ISOPROPANOL                        177          180      162.2           9.07    14.212     ( -5.85, 23.98)
   3       ETHYL ACETATE                      176          201      136.2          31.54    11.331     ( 19.65, 43.43)
   9       METHANOL                           176          179      133.3          25.28     8.861     ( 15.98, 34.58)
  10       ETHANOL                            177          178      116.2          34.39     6.925     ( 27.12, 41.65)
  12       N-BUTANOL                          177          197       84.3          56.60     7.642     ( 48.58, 64.62)
  14       N-PROPYL ACETATE                   177          195      128.3          33.57    10.173     ( 22.89, 44.24)
  15       ISOBUTYL ACETATE                   176          193      125.5          34.72     9.017     ( 25.25, 44.18)

  99       TOTAL HC                          1236         1325      886.0          32.62     9.344     ( 22.82, 42.43)
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RUN #    C-52       CATALYST INLET TEMP (DEG F)          599          SPACE VELOCITY                        29,531
MIXTURE  3          CATALYST OUTLET TEMP (DEG F)         622          RESIDENCE TIME (SECONDS)               0.039
                    CATALYST BED TEMP RISE (DEG F)        23          CATALYST BED PRESS DROP (" H2O)          0.5
                    MAIN HEATER TEMPERATURE (DEG F)     1001

                                                     AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                    CALCULATED    CONCENTRATION (PPMV-C)    ------------------------------------
 SPECIES                            INLET CONC    ----------------------               STD.         95% C.I.
  CODE         SPECIES               (PPMV-C)        INLET      OUTLET        MEAN      DEV.       ON THE MEAN
---------------------------------------------------------------------------------------------------------------
   1        ISOPROPANOL                180            208        10.0         95.17     0.487    ( 93.96, 96.38)
   3        ETHYL ACETATE              179            232         8.2         96.46     0.342    ( 95.61, 97.31)
   9        METHANOL                   179            224        <2.0        >99.11     0.056
  10        ETHANOL                    180            224        <2.0        >99.09     0.153
  12        N-BUTANOL                  179            220        <4.0        >98.18     0.131
  14        N-PROPYL ACETATE           179            215         6.7         96.89     0.312    ( 96.11, 97.66)
  15        ISOBUTYL ACETATE           179            211         5.4         97.45     0.340    ( 96.60, 98.29)

  99        TOTAL HC                  1254           1537        38.4         97.50     0.211    ( 96.98, 98.02)


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RUN #    C-52H      CATALYST INLET TEMP (DEG F)          599          SPACE VELOCITY                        29,531
MIXTURE  3          CATALYST OUTLET TEMP (DEG F)         622          RESIDENCE TIME (SECONDS)               0.039
                    CATALYST BED TEMP RISE (DEG F)        23          CATALYST BED PRESS DROP (" H2O)          0.5
                    MAIN HEATER TEMPERATURE (DEG F)     1001

                                                     AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                    CALCULATED    CONCENTRATION (PPMV-C)    ------------------------------------
 SPECIES                            INLET CONC    ----------------------               STD.         95% C.I.
  CODE         SPECIES               (PPMV-C)        INLET      OUTLET        MEAN      DEV.       ON THE MEAN
---------------------------------------------------------------------------------------------------------------
   1        ISOPROPANOL                180            189       145.0         23.43     3.124    ( 20.15, 26.70)
   3        ETHYL ACETATE              179            216        85.7         60.23     2.737    ( 57.36, 63.11)
   9        METHANOL                   179            218        77.5         64.24     3.221    ( 60.86, 67.62)
  10        ETHANOL                    180            218        65.0         70.05     3.523    ( 66.35, 73.74)
  12        N-BUTANOL                  179            207        46.1         77.59     1.928    ( 75.56, 79.61)
  14        N-PROPYL ACETATE           179            201        75.2         62.46     2.018    ( 60.34, 64.58)
  15        ISOBUTYL ACETATE           179            195        78.4         59.72     1.719    ( 57.91, 61.52)

  99        TOTAL HC                  1254           1446       573.1         60.29     2.264    ( 57.91, 62.67)
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RUN # C-53
MIXTURE 3

CATALYST INLET TEMP (DEG F)	601	SPACE VELOCITY	19,850
CATALYST OUTLET TEMP (DEG F)	618	RESIDENCE TIME (SECONDS)	0.058
CATALYST BED TEMP RISE (DEG F)	17	CATALYST BED PRESS DROP (" H2O)	
MAIN HEATER TEMPERATURE (DEG F)	1205		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	181	195	2.8	98.58	0.242	(97.98, 99.18)
3	ETHYL ACETATE	180	221	<2.0	>99.09	0.122	
9	METHANOL	180	238	<2.0	>99.16	0.093	
10	ETHANOL	181	220	<2.0	>99.07	0.162	
12	N-BUTANOL	181	218	<2.0	>99.07	0.150	
14	N-PROPYL ACETATE	181	206	<2.0	>99.02	0.120	
15	ISOBUTYL ACETATE	180	205	<2.0	>99.02	0.079	
99	TOTAL HC	1263	1506	14.8	99.01	0.103	(98.75, 99.27)

RUN # C-53H
MIXTURE 3

CATALYST INLET TEMP (DEG F)	601	SPACE VELOCITY	19,850
CATALYST OUTLET TEMP (DEG F)	618	RESIDENCE TIME (SECONDS)	0.058
CATALYST BED TEMP RISE (DEG F)	17	CATALYST BED PRESS DROP (" H2O)	
MAIN HEATER TEMPERATURE (DEG F)	1205		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	181	194	120.0	37.94	5.147	(32.70, 43.19)
3	ETHYL ACETATE	180	217	<2.0	>99.07	0.118	
9	METHANOL	180	231	22.3	90.37	1.063	(89.28, 91.45)
10	ETHANOL	181	209	19.0	90.87	1.606	(89.23, 92.50)
12	N-BUTANOL	181	209	11.7	94.37	1.276	(93.07, 95.67)
14	N-PROPYL ACETATE	181	206	<2.0	>99.02	0.143	
15	ISOBUTYL ACETATE	180	204	5.2	97.42	0.936	(96.47, 98.38)
99	TOTAL HC	1263	1472	182.1	87.58	1.282	(86.27, 88.89)

RUN # C-54
MIXTURE 3

CATALYST INLET TEMP (DEG F) 790
CATALYST OUTLET TEMP (DEG F) 816
CATALYST BED TEMP RISE (DEG F) 26
MAIN HEATER TEMPERATURE (DEG F) 1230

SPACE VELOCITY 49,576
RESIDENCE TIME (SECONDS) 0.019
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
1	ISOPROPANOL	177	187	13.4	92.87	0.225	(92.31, 93.42)
3	ETHYL ACETATE	176	210	2.9	98.63	0.334	(97.80, 99.46)
9	METHANOL	177	229	<2.2	>99.04	0.120	
10	ETHANOL	177	208	2.5	98.78	0.120	(98.48, 99.08)
12	N-BUTANOL	177	204	3.5	98.28	0.427	(97.22, 99.34)
14	N-PROPYL ACETATE	177	201	2.5	98.77	0.101	(98.52, 99.02)
15	ISOBUTYL ACETATE	177	190	5.7	97.02	0.189	(96.56, 97.49)
99	TOTAL HC	1239	1432	32.6	97.72	0.104	(97.46, 97.98)

RUN # C-54H
MIXTURE 3

CATALYST INLET TEMP (DEG F) 790
CATALYST OUTLET TEMP (DEG F) 816
CATALYST BED TEMP RISE (DEG F) 26
MAIN HEATER TEMPERATURE (DEG F) 1230

SPACE VELOCITY 49,576
RESIDENCE TIME (SECONDS) 0.019
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
1	ISOPROPANOL	177	197	171.6	12.78	6.678	(5.98, 19.58)
3	ETHYL ACETATE	176	224	22.6	89.84	0.910	(88.91, 90.77)
9	METHANOL	177	259	60.9	76.48	1.510	(74.95, 78.02)
10	ETHANOL	177	224	54.0	75.86	1.643	(74.19, 77.54)
12	N-BUTANOL	177	214	42.8	79.83	1.926	(77.87, 81.80)
14	N-PROPYL ACETATE	177	224	23.9	89.31	0.529	(88.77, 89.85)
15	ISOBUTYL ACETATE	177	209	39.9	81.00	0.874	(80.11, 81.89)
99	TOTAL HC	1239	1553	415.7	73.18	1.569	(71.58, 74.78)

RUN # C-55
MIXTURE 6
CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 625
CATALYST BED TEMP RISE (DEG F) 27
MAIN HEATER TEMPERATURE (DEG F) 940
SPACE VELOCITY 48,892
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
4	BENZENE	162	160	16.4	89.71	0.619	(89.06, 90.36)
5	N-HEXANE	162	153	17.0	88.92	0.725	(88.16, 89.68)
8	TOLUENE	161	160	17.3	89.23	0.701	(88.50, 89.97)
31	N-OCTANE	163	160	11.2	92.96	0.463	(92.48, 93.45)
32	N-DECANE	162	161	9.9	93.84	0.329	(93.50, 94.19)
33	P-XYLENE	161	160	15.0	90.57	0.497	(90.05, 91.10)
34	ISOPROPYL BENZENE	162	160	17.1	89.28	0.498	(88.76, 89.81)
99	TOTAL HC	1132	1116	104.0	90.66	0.524	(90.11, 91.21)

RUN # C-55H
MIXTURE 6
CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 625
CATALYST BED TEMP RISE (DEG F) 27
MAIN HEATER TEMPERATURE (DEG F) 940
SPACE VELOCITY 48,892
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
4	BENZENE	162	164	163.3	0.45	2.604	(-2.28, 3.19)
5	N-HEXANE	162	159	96.3	39.46	1.442	(37.95, 40.97)
8	TOLUENE	161	164	150.8	8.43	3.441	(4.82, 12.05)
31	N-OCTANE	163	164	55.5	66.12	1.025	(65.05, 67.20)
32	N-DECANE	162	165	52.5	68.17	0.784	(67.34, 68.99)
33	P-XYLENE	161	164	117.0	28.63	1.512	(27.04, 30.22)
34	ISOPROPYL BENZENE	162	166	118.2	28.87	1.307	(27.50, 30.24)
99	TOTAL HC	1132	1147	753.6	34.28	1.636	(32.56, 36.00)

RUN # C-56
MIXTURE 6

CATALYST INLET TEMP (DEG F) 595
CATALYST OUTLET TEMP (DEG F) 618
CATALYST BED TEMP RISE (DEG F) 23
MAIN HEATER TEMPERATURE (DEG F) 1039

SPACE VELOCITY 29,628
RESIDENCE TIME (SECONDS) 0.039
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	163	164	8.1	95.03	0.109	(94.92, 95.15)
5	N-HEXANE	163	161	10.7	93.37	0.224	(93.14, 93.61)
8	TOLUENE	163	164	9.1	94.45	0.156	(94.28, 94.61)
31	N-OCTANE	164	165	6.9	95.81	0.113	(95.69, 95.93)
32	N-DECANE	164	166	5.9	96.43	0.144	(96.28, 96.58)
33	P-XYLENE	163	164	8.5	94.85	0.087	(94.75, 94.94)
34	ISOPROPYL BENZENE	164	165	10.1	93.88	0.251	(93.62, 94.14)
99	TOTAL HC	1145	1151	59.4	94.84	0.119	(94.71, 94.96)

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RUN # C-56H
MIXTURE 6

CATALYST INLET TEMP (DEG F) 595
CATALYST OUTLET TEMP (DEG F) 618
CATALYST BED TEMP RISE (DEG F) 23
MAIN HEATER TEMPERATURE (DEG F) 1039

SPACE VELOCITY 29,628
RESIDENCE TIME (SECONDS) 0.039
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	163	165	163.3	1.29	2.339	(-1.17, 3.74)
5	N-HEXANE	163	161	102.5	36.30	1.197	(35.04, 37.55)
8	TOLUENE	163	167	148.5	11.38	3.782	(7.41, 15.35)
31	N-OCTANE	164	167	54.1	67.67	0.539	(67.10, 68.23)
32	N-DECANE	164	168	48.5	71.10	0.625	(70.44, 71.75)
33	P-XYLENE	163	167	112.7	32.73	1.249	(31.42, 34.04)
34	ISOPROPYL BENZENE	164	169	115.3	32.08	1.428	(30.58, 33.58)
99	TOTAL HC	1145	1167	745.1	36.14	1.484	(34.58, 37.70)

RUN # C-57
MIXTURE 6

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 618
CATALYST BED TEMP RISE (DEG F) 20
MAIN HEATER TEMPERATURE (DEG F) 1190

SPACE VELOCITY 20,437
RESIDENCE TIME (SECONDS) 0.056
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
4	BENZENE	171	158	4.0	97.42	0.571	(96.82, 98.02)
5	N-HEXANE	171	155	3.2	97.88	0.462	(97.39, 98.36)
8	TOLUENE	171	158	4.4	97.19	0.564	(96.60, 97.79)
31	N-OCTANE	172	158	<2.0	>98.72	0.214	
32	N-DECANE	171	160	<2.0	>98.74	0.185	
33	P-XYLENE	171	159	3.2	98.01	0.646	(97.33, 98.69)
34	ISOPROPYL BENZENE	172	158	3.6	97.70	0.651	(97.02, 98.38)
99	TOTAL HC	1200	1109	22.5	97.95	0.309	(97.63, 98.28)

RUN # C-57H
MIXTURE 6

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 618
CATALYST BED TEMP RISE (DEG F) 20
MAIN HEATER TEMPERATURE (DEG F) 1190

SPACE VELOCITY 20,437
RESIDENCE TIME (SECONDS) 0.056
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
4	BENZENE	171	159	156.2	2.18	2.395	(-0.33, 4.70)
5	N-HEXANE	171	155				
8	TOLUENE	171	160	119.5	25.24	3.986	(21.05, 29.42)
31	N-OCTANE	172	158	13.0	91.81	0.855	(90.92, 92.71)
32	N-DECANE	171	161	13.5	91.63	0.795	(90.79, 92.46)
33	P-XYLENE	171	159	66.4	58.42	1.465	(56.88, 59.96)
34	ISOPROPYL BENZENE	172	162	71.3	56.08	1.525	(54.48, 57.69)
99	TOTAL HC	1200	1117	439.9	60.61	1.267	(59.28, 61.94)

RUN # C-58
MIXTURE 6
CATALYST INLET TEMP (DEG F) 697
CATALYST OUTLET TEMP (DEG F) 721
CATALYST BED TEMP RISE (DEG F) 24
MAIN HEATER TEMPERATURE (DEG F) 1077
SPACE VELOCITY 49,772
RESIDENCE TIME (SECONDS) 0.021
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
4	BENZENE	166	148	14.6	90.15	0.440	(89.68, 90.61)
5	N-HEXANE	166	148	13.1	91.19	0.381	(90.79, 91.59)
8	TOLUENE	166	150	14.9	90.03	0.536	(89.47, 90.59)
31	N-OCTANE	167	150	11.3	92.45	0.364	(92.07, 92.84)
32	N-DECANE	167	150	10.1	93.27	0.258	(93.00, 93.54)
33	P-XYLENE	166	148	12.8	91.38	0.264	(91.11, 91.66)
34	ISOPROPYL BENZENE	167	148	14.6	90.09	0.332	(89.74, 90.44)
99	TOTAL HC	1166	1044	91.5	91.23	0.328	(90.88, 91.57)

RUN # C-59
MIXTURE 6
CATALYST INLET TEMP (DEG F) 790
CATALYST OUTLET TEMP (DEG F) 818
CATALYST BED TEMP RISE (DEG F) 28
MAIN HEATER TEMPERATURE (DEG F) 1239
SPACE VELOCITY 49,381
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
4	BENZENE	160	152	14.7	90.32	0.304	(90.01, 90.64)
5	N-HEXANE	160	149	11.5	92.29	0.142	(92.14, 92.43)
8	TOLUENE	159	152	13.1	91.35	0.499	(90.83, 91.88)
31	N-OCTANE	161	151	8.1	94.67	0.242	(94.42, 94.93)
32	N-DECANE	160	152	6.8	95.50	0.342	(95.14, 95.86)
33	P-XYLENE	160	150	9.7	93.57	0.230	(93.33, 93.81)
34	ISOPROPYL BENZENE	160	151	11.6	92.27	0.255	(92.00, 92.54)
99	TOTAL HC	1119	1059	75.6	92.85	0.253	(92.59, 93.12)

RUN #	C-59H	CATALYST INLET TEMP (DEG F)	790
MIXTURE	6	CATALYST OUTLET TEMP (DEG F)	818
		CATALYST BED TEMP RISE (DEG F)	28
		MAIN HEATER TEMPERATURE (DEG F)	1239

SPACE VELOCITY	49,381
RESIDENCE TIME (SECONDS)	0.020
CATALYST BED PRESS DROP (" H2O)	

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
4	BENZENE	160	160	163.0	>1.79	5.016	
5	N-HEXANE	160	156	77.3	50.45	2.978	(47.33, 53.58)
8	TOLUENE	159	161	139.8	13.08	6.080	(6.69, 19.46)
31	N-OCTANE	161	160	42.9	73.17	2.136	(70.93, 75.41)
32	N-DECANE	160	161	40.2	75.03	2.006	(72.93, 77.14)
33	P-XYLENE	160	161	99.4	38.33	3.720	(34.42, 42.23)
34	ISOPROPYL BENZENE	160	163	104.2	36.23	3.760	(32.29, 40.18)
99	TOTAL HC	1119	1126	666.8	40.61	3.494	(36.94, 44.28)

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RUN #	C-60	CATALYST INLET TEMP (DEG F)	597
MIXTURE	5	CATALYST OUTLET TEMP (DEG F)	626
		CATALYST BED TEMP RISE (DEG F)	29
		MAIN HEATER TEMPERATURE (DEG F)	940

SPACE VELOCITY	49,185
RESIDENCE TIME (SECONDS)	0.023
CATALYST BED PRESS DROP (" H2O)	1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	189	175	16.0	90.88	0.231	(90.30, 91.45)
26	ISOBUTYL ALDEHYDE	189	179	11.6	93.53	1.001	(91.04, 96.02)
27	N-BUTYL ALDEHYDE	189	179	7.6	95.75	1.188	(92.80, 98.70)
28	N-VALERALDEHYDE	189	176	11.7	93.39	0.549	(92.03, 94.75)
29	ISOVATERALDEHYDE	189	174	11.2	93.55	0.646	(91.95, 95.16)
99	TOTAL HC	947	884	58.1	93.43	0.376	(92.49, 94.36)

RUN # C-60H
MIXTURE 5

CATALYST INLET TEMP (DEG F) 597
CATALYST OUTLET TEMP (DEG F) 626
CATALYST BED TEMP RISE (DEG F) 29
MAIN HEATER TEMPERATURE (DEG F) 940

SPACE VELOCITY 49,185
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	189	170	146.5	13.89	6.288	(7.29, 20.49)
26	ISOBUTYL ALDEHYDE	189	173	115.2	33.20	5.147	(27.80, 38.60)
27	N-BUTYL ALDEHYDE	189	177	88.6	50.02	3.115	(46.75, 53.29)
28	N-VALERALDEHYDE	189	169	77.3	54.21	3.381	(50.66, 57.75)
29	ISOVATERALDEHYDE	189	168	87.4	48.06	4.592	(43.24, 52.88)
99	TOTAL HC	947	859	515.1	39.90	4.377	(35.31, 44.50)

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RUN # C-61
MIXTURE 5

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 614
CATALYST BED TEMP RISE (DEG F) 16
MAIN HEATER TEMPERATURE (DEG F) 1102

SPACE VELOCITY 19,850
RESIDENCE TIME (SECONDS) 0.058
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	174	156	<4.0	>97.43	0.082	
26	ISOBUTYL ALDEHYDE	174	158	<4.0	>97.47	0.081	
27	N-BUTYL ALDEHYDE	174	164	<4.0	>97.57	0.067	
28	N-VALERALDEHYDE	174	154	<4.0	>97.41	0.105	
29	ISOVATERALDEHYDE	174	153	<4.0	>97.38	0.094	
99	TOTAL HC	869	786	20.0	97.46	0.084	(97.25, 97.66)

RUN #	C-61H	CATALYST INLET TEMP (DEG F)	598	SPACE VELOCITY	19,850
MIXTURE	5	CATALYST OUTLET TEMP (DEG F)	614	RESIDENCE TIME (SECONDS)	0.058
		CATALYST BED TEMP RISE (DEG F)	16	CATALYST BED PRESS DROP (" H2O)	
		MAIN HEATER TEMPERATURE (DEG F)	1102		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	174	163	74.9	54.30	1.775	(52.43, 56.16)
26	ISOBUTYL ALDEHYDE	174	165	54.0	67.40	1.717	(65.60, 69.20)
27	N-BUTYL ALDEHYDE	174	169	17.4	89.72	0.900	(88.77, 90.66)
28	N-VALERALDEHYDE	174	163	15.3	90.67	1.641	(88.95, 92.39)
29	ISOVATERALDEHYDE	174	161	17.6	89.13	1.044	(88.03, 90.22)
99	TOTAL HC	869	823	179.2	78.26	1.273	(76.92, 79.60)

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RUN #	C-62	CATALYST INLET TEMP (DEG F)	795	SPACE VELOCITY	49,087
MIXTURE	5	CATALYST OUTLET TEMP (DEG F)	816	RESIDENCE TIME (SECONDS)	0.020
		CATALYST BED TEMP RISE (DEG F)	21	CATALYST BED PRESS DROP (" H2O)	1.0
		MAIN HEATER TEMPERATURE (DEG F)	1220		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	171	168	5.4	96.77	0.439	(95.68, 97.86)
26	ISOBUTYL ALDEHYDE	171	172	4.2	97.54	0.139	(97.19, 97.88)
27	N-BUTYL ALDEHYDE	171	173	<4.0	>97.69	0.020	
28	N-VALERALDEHYDE	172	166	<4.0	>97.60	0.044	
29	ISOVATERALDEHYDE	172	166	<4.2	>97.49	0.207	
99	TOTAL HC	857	846	21.9	97.42	0.051	(97.29, 97.55)

RUN # C-62H
MIXTURE 5

CATALYST INLET TEMP (DEG F) 795
CATALYST OUTLET TEMP (DEG F) 816
CATALYST BED TEMP RISE (DEG F) 21
MAIN HEATER TEMPERATURE (DEG F) 1220

SPACE VELOCITY 49,087
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
25	PROPIONALDEHYDE	171	173	102.0	41.30	1.792	(39.42, 43.18)
26	ISOBUTYL ALDEHYDE	171	177	76.7	56.64	0.400	(56.22, 57.06)
27	N-BUTYL ALDEHYDE	171	180	36.2	79.88	0.433	(79.42, 80.33)
28	N-VALERALDEHYDE	172	171	29.7	82.63	0.772	(81.82, 83.44)
29	ISOVATERALDEHYDE	172	170	35.7	79.00	0.736	(78.23, 79.77)
99	TOTAL HC	857	872	280.4	67.84	0.551	(67.26, 68.42)

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RUN # C-63
MIXTURE 4

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 626
CATALYST BED TEMP RISE (DEG F) 28
MAIN HEATER TEMPERATURE (DEG F) 945

SPACE VELOCITY 49,478
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	166	178	19.3	89.19	0.647	(87.59, 90.80)
16	ACETONE	165	175	23.5	86.56	0.442	(85.47, 87.66)
17	METHYL ISOBUTYL KETONE	166	179	19.6	89.08	0.443	(87.98, 90.18)
18	CYCLOHEXANONE	166	182	9.6	94.76	0.262	(94.11, 95.41)
22	ETHYL CELLOSOLVE	166	205	5.1	97.52	0.663	(95.88, 99.17)
23	BUTYL CELLUSOLVE	166	195	9.7	95.03	0.291	(94.31, 95.76)
24	DIOXANE	166	178	20.8	88.29	0.524	(86.99, 89.60)
99	TOTAL HC	1162	1292	107.6	91.68	0.308	(90.92, 92.45)

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RUN #    C-63H     CATALYST INLET TEMP (DEG F)         598         SPACE VELOCITY                         49,478
MIXTURE  4         CATALYST OUTLET TEMP (DEG F)        626         RESIDENCE TIME (SECONDS)                0.023
                   CATALYST BED TEMP RISE (DEG F)       28         CATALYST BED PRESS DROP (" H2O)          1.0
                   MAIN HEATER TEMPERATURE (DEG F)     945

                                                     AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                        CALCULATED  CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                 INLET CONC  ----------------------              STD.       95% C.I.
 CODE        SPECIES                    (PPMV-C)      INLET      OUTLET        MEAN     DEV.     ON THE MEAN
-----------------------------------------------------------------------------------------------------------------

  2        METHYL ETHYL KETONE             166          177       132.5        25.47    0.807    ( 24.18, 26.75)
 16        ACETONE                         165          175       148.0        15.44    1.014    ( 13.83, 17.05)
 17        METHYL ISOBUTYL KETONE          166          178       115.3        35.36    1.026    ( 33.73, 36.99)
 18        CYCLOHEXANONE                   166          182        76.0        58.31    0.964    ( 56.77, 59.84)
 22        ETHYL CELLOSOLVE                166          207        78.0        62.35    1.150    ( 60.52, 64.18)
 23        BUTYL CELLUSOLVE                166          195        74.3        61.93    1.499    ( 59.55, 64.31)
 24        DIOXANE                         166          177       155.0        12.81    3.857    (  6.68, 18.95)

 99        TOTAL HC                       1162         1293       779.1        39.78    1.144    ( 37.96, 41.60)


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RUN #    C-64      CATALYST INLET TEMP (DEG F)         598         SPACE VELOCITY                         20,437
MIXTURE  4         CATALYST OUTLET TEMP (DEG F)        618         RESIDENCE TIME (SECONDS)                0.056
                   CATALYST BED TEMP RISE (DEG F)       20         CATALYST BED PRESS DROP (" H2O)          0.4
                   MAIN HEATER TEMPERATURE (DEG F)    1078

                                                     AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                        CALCULATED  CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                 INLET CONC  ----------------------              STD.       95% C.I.
 CODE        SPECIES                    (PPMV-C)      INLET      OUTLET        MEAN     DEV.     ON THE MEAN
-----------------------------------------------------------------------------------------------------------------

  2        METHYL ETHYL KETONE             172          179        <4.0       >97.76    0.238
 16        ACETONE                         171          176        <4.0       >97.71    0.254
 17        METHYL ISOBUTYL KETONE          171          181        <4.0       >97.77    0.253
 18        CYCLOHEXANONE                   172          184        <4.0       >97.82    0.237
 22        ETHYL CELLOSOLVE                171          214        <4.0       >98.13    0.175
 23        BUTYL CELLUSOLVE                172          205        <4.0       >98.04    0.181
 24        DIOXANE                         172          180        <4.1       >97.69    0.163

 99        TOTAL HC                       1200         1321        28.1        97.86    0.209    ( 97.34, 98.37)
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RUN # C-64H
MIXTURE 4

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 618
CATALYST BED TEMP RISE (DEG F) 20
MAIN HEATER TEMPERATURE (DEG F) 1078

SPACE VELOCITY 20,437
RESIDENCE TIME (SECONDS) 0.056
CATALYST BED PRESS DROP (" H2O) 0.4

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	172	188	41.9	77.78	1.739	(75.95, 79.60)
16	ACETONE	171	186	81.1	56.39	1.495	(54.82, 57.95)
17	METHYL ISOBUTYL KETONE	171	188	29.0	84.63	1.807	(82.73, 86.53)
18	CYCLOHEXANONE	172	194	15.1	92.26	0.869	(91.35, 93.17)
22	ETHYL CELLOSOLVE	171	223	10.9	95.11	0.839	(94.23, 96.00)
23	BUTYL CELLUSOLVE	172	212	13.4	93.72	1.047	(92.62, 94.82)
24	DIOXANE	172	188	99.8	47.03	8.454	(38.16, 55.91)
99	TOTAL HC	1200	1382	291.3	78.95	2.205	(76.63, 81.26)

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RUN # C-65
MIXTURE 4

CATALYST INLET TEMP (DEG F) 790
CATALYST OUTLET TEMP (DEG F) 817
CATALYST BED TEMP RISE (DEG F) 27
MAIN HEATER TEMPERATURE (DEG F) 1218

SPACE VELOCITY 49,283
RESIDENCE TIME (SECONDS) 0.048
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	166	208	6.9	96.71	0.290	(95.99, 97.43)
16	ACETONE	165	205	9.4	95.41	0.061	(95.26, 95.56)
17	METHYL ISOBUTYL KETONE	165	210	7.7	96.36	0.076	(96.17, 96.55)
18	CYCLOHEXANONE	166	213	<4.0	>98.13	0.028	
22	ETHYL CELLOSOLVE	165	248	<4.0	>98.39	0.026	
23	BUTYL CELLUSOLVE	166	237	<4.0	>98.31	0.040	
24	DIOXANE	166	208	14.4	93.10	0.302	(92.35, 93.85)
99	TOTAL HC	1159	1530	50.3	96.71	0.089	(96.49, 96.93)

RUN # C-65H
MIXTURE 4

CATALYST INLET TEMP (DEG F) 790
CATALYST OUTLET TEMP (DEG F) 817
CATALYST BED TEMP RISE (DEG F) 27
MAIN HEATER TEMPERATURE (DEG F) 1218

SPACE VELOCITY 19,948
RESIDENCE TIME (SECONDS) 0.048
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	166	193	78.6	59.39	4.184	(55.52, 63.26)
16	ACETONE	165	190	106.2	44.21	1.967	(42.39, 46.03)
17	METHYL ISOBUTYL KETONE	165	195	61.3	68.60	0.377	(68.25, 68.95)
18	CYCLOHEXANONE	166	199	35.7	82.13	0.263	(81.89, 82.38)
22	ETHYL CELLOSOLVE	165	231	29.3	87.34	0.376	(86.99, 87.68)
23	BUTYL CELLUSOLVE	166	221	45.3	79.43	4.368	(75.39, 83.47)
24	DIOXANE	166	193	131.4	31.97	1.257	(30.80, 33.13)
99	TOTAL HC	1159	1425	487.9	65.74	1.038	(64.78, 66.70)

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RUN # C-66
MIXTURE 7

CATALYST INLET TEMP (DEG F) 600
CATALYST OUTLET TEMP (DEG F) 618
CATALYST BED TEMP RISE (DEG F) 18
MAIN HEATER TEMPERATURE (DEG F) 1165

SPACE VELOCITY 20,046
RESIDENCE TIME (SECONDS) 0.056
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
37	ACRYLONITRILE	540	494	10.1	97.96	0.158	(97.80, 98.13)
49	M-CRESOL	556	608	<5.0	>99.18	0.023	
99	TOTAL HC	1095	1102	15.1	98.63	0.082	(98.55, 98.72)

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RUN #     C-66H      CATALYST INLET TEMP (DEG F)          600          SPACE VELOCITY                           20,046
MIXTURE   7          CATALYST OUTLET TEMP (DEG F)         618          RESIDENCE TIME (SECONDS)                  0.056
                     CATALYST BED TEMP RISE (DEG F)        18          CATALYST BED PRESS DROP (" H2O)
                     MAIN HEATER TEMPERATURE (DEG F)     1165

                                                      AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                  INLET CONC   ----------------------                STD.      95% C.I.
 CODE        SPECIES                     (PPMV-C)       INLET      OUTLET        MEAN       DEV.     ON THE MEAN
-----------------------------------------------------------------------------------------------------------------
  37       ACRYLONITRILE                    540           494       366.0         25.79     6.205    (-29.94, 81.51)
  49       M-CRESOL                         556           590        27.0         95.43     0.287    ( 92.85, 98.00)

  99       TOTAL HC                        1095          1085       393.0         63.74     2.140    ( 44.52, 82.95)


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RUN #     C-67       CATALYST INLET TEMP (DEG F)          649          SPACE VELOCITY                           29,726
MIXTURE   7          CATALYST OUTLET TEMP (DEG F)         672          RESIDENCE TIME (SECONDS)                  0.036
                     CATALYST BED TEMP RISE (DEG F)        23          CATALYST BED PRESS DROP (" H2O)
                     MAIN HEATER TEMPERATURE (DEG F)     1078

                                                      AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                                  INLET CONC   ----------------------                STD.      95% C.I.
 CODE        SPECIES                     (PPMV-C)       INLET      OUTLET        MEAN       DEV.     ON THE MEAN
-----------------------------------------------------------------------------------------------------------------
  37       ACRYLONITRILE                    540           493        17.5         96.43     0.284    ( 96.13, 96.73)
  49       M-CRESOL                         556           638        <5.0        >99.22     0.014

  99       TOTAL HC                        1095          1131        22.5         98.01     0.086    ( 97.92, 98.10)


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RUN #    C-67H      CATALYST INLET TEMP (DEG F)          649          SPACE VELOCITY                     29,726
MIXTURE  7          CATALYST OUTLET TEMP (DEG F)         672          RESIDENCE TIME (SECONDS)            0.036
                    CATALYST BED TEMP RISE (DEG F)        23          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)     1078

                                                       AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                      CALCULATED    CONCENTRATION (PPMV-C)     ------------------------------------
SPECIES                               INLET CONC    ----------------------                STD.        95% C.I.
 CODE        SPECIES                   (PPMV-C)       INLET      OUTLET        MEAN       DEV.      ON THE MEAN
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  37       ACRYLONITRILE                  540           490       559.0      >12.19      6.584
  49       M-CRESOL                       556           669        95.7       85.68      1.086    ( 84.58, 86.79)

  99       TOTAL HC                      1095          1061       654.7       35.32     19.314    ( 15.64, 54.99)


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RUN #    C-68       CATALYST INLET TEMP (DEG F)          648          SPACE VELOCITY                     20,046
MIXTURE  7          CATALYST OUTLET TEMP (DEG F)         660          RESIDENCE TIME (SECONDS)            0.054
                    CATALYST BED TEMP RISE (DEG F)        12          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)     1242

                                                       AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                      CALCULATED    CONCENTRATION (PPMV-C)     ------------------------------------
SPECIES                               INLET CONC    ----------------------                STD.        95% C.I.
 CODE        SPECIES                   (PPMV-C)       INLET      OUTLET        MEAN       DEV.      ON THE MEAN
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  37       ACRYLONITRILE                  545           500        16.5       96.68      0.375    ( 96.29, 97.08)
  49       M-CRESOL                       561           406        <5.0      >98.77      0.067

  99       TOTAL HC                      1106           906        21.5       97.62      0.211    ( 97.40, 97.84)


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RUN #	C-69	CATALYST INLET TEMP (DEG F)	699	SPACE VELOCITY	29,824
MIXTURE	7	CATALYST OUTLET TEMP (DEG F)	720	RESIDENCE TIME (SECONDS)	0.035
		CATALYST BED TEMP RISE (DEG F)	21	CATALYST BED PRESS DROP (" H2O)	
		MAIN HEATER TEMPERATURE (DEG F)	1130		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
37	ACRYLONITRILE	541	511	16.5	96.78	0.113	(96.66, 96.90)
49	M-CRESOL	557	427	<5.0	>98.83	0.027	
99	TOTAL HC	1098	938	21.5	97.71	0.048	(97.66, 97.76)

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RUN #	C-70	CATALYST INLET TEMP (DEG F)	640	SPACE VELOCITY	20,046
MIXTURE	8	CATALYST OUTLET TEMP (DEG F)	648	RESIDENCE TIME (SECONDS)	0.056
		CATALYST BED TEMP RISE (DEG F)	8	CATALYST BED PRESS DROP (" H2O)	0.5
		MAIN HEATER TEMPERATURE (DEG F)	1257		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	173	180	<2.0	>98.89	0.055	
41	CARBON TETRACHLORIDE	172	186	58.0	69.02	3.785	(65.52, 72.52)
42	ETHYLENE DICHLORIDE	172	183	<3.5	>98.12	0.490	
44	TRICHLOROETHYLENE	173	183	46.6	74.58	3.799	(71.07, 78.10)
50	1,1-DICHLOROETHANE	172	182	10.8	94.06	1.655	(92.53, 95.59)
51	1,1,2-TRICHLOROETHANE	173	183	<5.0	>97.27	0.125	
52	TETRACHLOROETHYLENE	173	184	121.0	34.60	5.309	(29.69, 39.51)
99	TOTAL HC	1206	1284	246.8	80.80	1.420	(79.48, 82.11)

RUN # C-70H
MIXTURE 8

CATALYST INLET TEMP (DEG F) 640
CATALYST OUTLET TEMP (DEG F) 648
CATALYST BED TEMP RISE (DEG F) 8
MAIN HEATER TEMPERATURE (DEG F) 1257

SPACE VELOCITY 20,046
RESIDENCE TIME (SECONDS) 0.056
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	173	184	<2.0	>98.91	0.060	
41	CARBON TETRACHLORIDE	172	190	67.4	64.61	2.401	(62.09, 67.13)
42	ETHYLENE DICHLORIDE	172	187	<4.6	>97.54	0.543	
44	TRICHLOROETHYLENE	173	188	49.3	73.77	2.672	(70.96, 76.57)
50	1,1-DICHLOROETHANE	172	186	9.3	95.02	1.062	(93.90, 96.13)
51	1,1,2-TRICHLOROETHANE	173	187	<5.0	>97.33	0.135	
52	TETRACHLOROETHYLENE	173	189	119.5	36.78	3.428	(33.18, 40.38)
99	TOTAL HC	1206	1314	257.1	80.42	1.256	(79.10, 81.74)

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RUN # C-71
MIXTURE 8

CATALYST INLET TEMP (DEG F) 698
CATALYST OUTLET TEMP (DEG F) 706
CATALYST BED TEMP RISE (DEG F) 8
MAIN HEATER TEMPERATURE (DEG F) 1180

SPACE VELOCITY 29,726
RESIDENCE TIME (SECONDS) 0.036
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	172	179	74.5	58.52	6.674	(51.51, 65.52)
41	CARBON TETRACHLORIDE	172	187	45.4	75.83	1.463	(74.29, 77.36)
42	ETHYLENE DICHLORIDE	171	185	28.8	84.45	4.320	(79.92, 88.99)
44	TRICHLOROETHYLENE	172	186	152.8	17.82	2.231	(15.48, 20.16)
50	1,1-DICHLOROETHANE	171	183	76.0	58.61	1.217	(57.34, 59.89)
51	1,1,2-TRICHLOROETHANE	172	186	37.1	80.03	4.011	(75.82, 84.24)
52	TETRACHLOROETHYLENE	172	187	167.5	10.57	2.603	(7.84, 13.30)
99	TOTAL HC	1200	1296	582.2	55.07	2.584	(52.36, 57.78)

RUN # C-71H
MIXTURE 8

CATALYST INLET TEMP (DEG F) 698
CATALYST OUTLET TEMP (DEG F) 706
CATALYST BED TEMP RISE (DEG F) 8
MAIN HEATER TEMPERATURE (DEG F) 1180

SPACE VELOCITY 29,726
RESIDENCE TIME (SECONDS) 0.036
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	172	175	72.9	58.35	1.644	(56.62, 60.08)
41	CARBON TETRACHLORIDE	172	183	83.1	54.58	0.521	(54.04, 55.13)
42	ETHYLENE DICHLORIDE	171	181	29.7	83.58	0.592	(82.96, 84.20)
44	TRICHLOROETHYLENE	172	181	150.7	16.94	1.313	(15.56, 18.32)
50	1,1-DICHLOROETHANE	171	179	85.1	52.49	0.735	(51.72, 53.26)
51	1,1,2-TRICHLOROETHANE	172	181	50.5	72.13	1.065	(71.01, 73.25)
52	TETRACHLOROETHYLENE	172	183	161.7	11.69	1.891	(9.71, 13.68)
99	TOTAL HC	1200	1263	633.7	49.86	0.949	(48.87, 50.86)

RUN # C-72
MIXTURE 8

CATALYST INLET TEMP (DEG F) 603
CATALYST OUTLET TEMP (DEG F) 699
CATALYST BED TEMP RISE (DEG F) 96
MAIN HEATER TEMPERATURE (DEG F) 1160

SPACE VELOCITY 19,850
RESIDENCE TIME (SECONDS) 0.056
CATALYST BED PRESS DROP (" H2O) 0.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	171	174	12.8	92.56	3.300	(89.50, 95.61)
41	CARBON TETRACHLORIDE	171	177	92.5	47.61	6.131	(41.94, 53.28)
42	ETHYLENE DICHLORIDE	170	175	<5.0	>97.13	0.304	
44	TRICHLOROETHYLENE	171	176	133.7	23.61	10.199	(14.18, 33.05)
50	1,1-DICHLOROETHANE	170	175	59.0	66.07	6.366	(60.18, 71.96)
51	1,1,2-TRICHLOROETHANE	171	175	<5.0	>97.13	0.292	
52	TETRACHLOROETHYLENE	171	176	177.0	>0.48	11.798	
99	TOTAL HC	1195	1231	485.1	60.40	5.188	(55.60, 65.20)

RUN # C-73
MIXTURE 8

CATALYST INLET TEMP (DEG F) 599
CATALYST OUTLET TEMP (DEG F) 602
CATALYST BED TEMP RISE (DEG F) 3
MAIN HEATER TEMPERATURE (DEG F) 1035

SPACE VELOCITY 29,531
RESIDENCE TIME (SECONDS) 0.039
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	172	169	172.8	>1.90	6.572	
41	CARBON TETRACHLORIDE	172	172	155.2	10.09	6.319	(3.46, 16.73)
42	ETHYLENE DICHLORIDE	171	170	158.3	7.35	6.172	(0.87, 13.83)
44	TRICHLOROETHYLENE	172	171	170.3	0.63	6.475	(-6.16, 7.43)
50	1,1-DICHLOROETHANE	171	170	97.5	42.81	4.085	(38.52, 47.09)
51	1,1,2-TRICHLOROETHANE	173	171	163.0	4.71	5.718	(-1.29, 10.71)
52	TETRACHLOROETHYLENE	173	171	180.5	>5.23	6.746	
99	TOTAL HC	1205	1197	1097.6	8.34	6.003	(2.03, 14.64)

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RUN # C-73H
MIXTURE 8

CATALYST INLET TEMP (DEG F) 599
CATALYST OUTLET TEMP (DEG F) 602
CATALYST BED TEMP RISE (DEG F) 3
MAIN HEATER TEMPERATURE (DEG F) 1035

SPACE VELOCITY 29,531
RESIDENCE TIME (SECONDS) 0.039
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	172	180	185.3	>2.75	3.470	
41	CARBON TETRACHLORIDE	172	183	174.5	4.92	3.452	(1.30, 8.55)
42	ETHYLENE DICHLORIDE	171	181	171.5	5.53	3.196	(2.18, 8.89)
44	TRICHLOROETHYLENE	172	182	185.3	>1.81	3.423	
50	1,1-DICHLOROETHANE	171	181	150.0	17.38	3.047	(14.18, 20.57)
51	1,1,2-TRICHLOROETHANE	173	181	180.5	0.37	3.532	(-3.34, 4.08)
52	TETRACHLOROETHYLENE	173	183	195.2	>6.63	3.930	
99	TOTAL HC	1205	1274	1242.3	2.42	3.411	(-1.16, 6.00)

RUN # C-74
MIXTURE 8

CATALYST INLET TEMP (DEG F) 793
CATALYST OUTLET TEMP (DEG F) 800
CATALYST BED TEMP RISE (DEG F) 7
MAIN HEATER TEMPERATURE (DEG F) 1230

SPACE VELOCITY 49,381
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	171	191	97.7	48.98	3.064	(45.77, 52.20)
41	CARBON TETRACHLORIDE	170	197	34.6	82.46	0.833	(81.59, 83.34)
42	ETHYLENE DICHLORIDE	170	194	47.9	75.45	2.338	(73.00, 77.90)
44	TRICHLOROETHYLENE	171	194	161.8	16.97	1.191	(15.72, 18.22)
50	1,1-DICHLOROETHANE	170	193	93.3	51.85	0.590	(51.23, 52.47)
51	1,1,2-TRICHLOROETHANE	171	194	40.4	79.22	1.568	(77.57, 80.86)
52	TETRACHLOROETHYLENE	171	196	172.0	12.36	1.147	(11.15, 13.56)
99	TOTAL HC	1192	1361	647.8	52.47	1.399	(51.00, 53.94)

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RUN # C-75
MIXTURE 8

CATALYST INLET TEMP (DEG F) 597
CATALYST OUTLET TEMP (DEG F) 600
CATALYST BED TEMP RISE (DEG F) 3
MAIN HEATER TEMPERATURE (DEG F) 940

SPACE VELOCITY 49,087
RESIDENCE TIME (SECONDS) 0.024
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	167	154	153.0	0.54	6.041	(-5.80, 6.88)
41	CARBON TETRACHLORIDE	167	161	129.5	19.53	5.103	(14.17, 24.89)
42	ETHYLENE DICHLORIDE	166	159	138.5	12.97	5.300	(7.41, 18.54)
44	TRICHLOROETHYLENE	167	159	153.3	3.59	5.470	(-2.15, 9.34)
50	1,1-DICHLOROETHANE	166	157	74.2	52.71	3.277	(49.27, 56.15)
51	1,1,2-TRICHLOROETHANE	168	160	148.2	7.60	5.353	(1.98, 13.22)
52	TETRACHLOROETHYLENE	167	161	155.8	3.15	5.465	(-2.59, 8.88)
99	TOTAL HC	1168	1112	952.6	14.27	5.116	(8.90, 19.64)

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RUN #    C-76       CATALYST INLET TEMP (DEG F)         597          SPACE VELOCITY                          49,283
MIXTURE             CATALYST OUTLET TEMP (DEG F)        607          RESIDENCE TIME (SECONDS)                 0.024
                    CATALYST BED TEMP RISE (DEG F)       10          CATALYST BED PRESS DROP (" H2O)          1.0
                    MAIN HEATER TEMPERATURE (DEG F)     940

                                                             AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                           CALCULATED     CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                                    INLET CONC     ----------------------                STD.        95% C.I.
 CODE         SPECIES                       (PPMV-C)        INLET       OUTLET       MEAN       DEV.      ON THE MEAN
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  50      1,1-DICHLOROETHANE                                 1294        794.3        38.65      1.636    ( 37.29, 40.02)


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RUN #    C-76H      CATALYST INLET TEMP (DEG F)         597          SPACE VELOCITY                          49,283
MIXTURE             CATALYST OUTLET TEMP (DEG F)        607          RESIDENCE TIME (SECONDS)                 0.024
                    CATALYST BED TEMP RISE (DEG F)       10          CATALYST BED PRESS DROP (" H2O)          1.0
                    MAIN HEATER TEMPERATURE (DEG F)     940

                                                             AVERAGE MEASURED          DESTRUCTION EFFICIENCY (%)
                                           CALCULATED     CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                                    INLET CONC     ----------------------                STD.        95% C.I.
 CODE         SPECIES                       (PPMV-C)        INLET       OUTLET       MEAN       DEV.      ON THE MEAN
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  50      1,1-DICHLOROETHANE                                 1291       1014.3        21.43      2.206    ( 19.58, 23.27)


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RUN # C-78
MIXTURE 8

CATALYST INLET TEMP (DEG F) 649
CATALYST OUTLET TEMP (DEG F) 653
CATALYST BED TEMP RISE (DEG F) 4
MAIN HEATER TEMPERATURE (DEG F) 1020

SPACE VELOCITY 49,478
RESIDENCE TIME (SECONDS) 0.022
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	STD. DEV.	95% C.I. ON THE MEAN
39	METHYLENE CHLORIDE	166	165	156.8	5.36	2.569	(2.66, 8.06)
41	CARBON TETRACHLORIDE	166	169	133.2	21.54	1.805	(19.65, 23.44)
42	ETHYLENE DICHLORIDE	165	166	142.7	14.34	2.251	(11.98, 16.71)
44	TRICHLOROETHYLENE	166	166	155.7	6.63	2.279	(4.24, 9.02)
50	1,1-DICHLOROETHANE	165	166	71.2	57.13	1.123	(55.95, 58.31)
51	1,1,2-TRICHLOROETHANE	167	166	143.5	13.93	2.178	(11.64, 16.21)
52	TETRACHLOROETHYLENE	166	168	157.0	6.85	2.140	(4.60, 9.09)
99	TOTAL HC	1163	1169	960.0	17.95	1.997	(15.85, 20.05)

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RUN # C-79
MIXTURE 1

CATALYST INLET TEMP (DEG F) 597
CATALYST OUTLET TEMP (DEG F) 617
CATALYST BED TEMP RISE (DEG F) 20
MAIN HEATER TEMPERATURE (DEG F) 940

SPACE VELOCITY 49,478
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	239	266	59.0	77.82	0.450	(77.41, 78.24)
2	METHYL ETHYL KETONE	238	265	30.9	88.37	0.271	(88.12, 88.62)
3	ETHYL ACETATE	239	265	52.8	80.11	0.420	(79.73, 80.50)
4	BENZENE	240	264	42.1	84.09	0.231	(83.87, 84.30)
5	N-HEXANE	238	264	133.6	49.56	1.379	(48.29, 50.84)
99	TOTAL HC	1194	1326	318.3	76.00	0.502	(75.53, 76.46)

RUN # C-80
MIXTURE 1

CATALYST INLET TEMP (DEG F) 798
CATALYST OUTLET TEMP (DEG F) 818
CATALYST BED TEMP RISE (DEG F) 221
MAIN HEATER TEMPERATURE (DEG F) 1235

SPACE VELOCITY 49,674
RESIDENCE TIME (SECONDS) 0.021
CATALYST BED PRESS DROP (" H2O) 1.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	236	273	11.7	95.70	0.561	(95.11, 96.29)
2	METHYL ETHYL KETONE	235	273	8.2	96.98	0.396	(96.57, 97.40)
3	ETHYL ACETATE	235	273	2.3	99.14	0.066	(99.07, 99.21)
4	BENZENE	237	273	33.8	87.58	1.231	(86.29, 88.87)
5	N-HEXANE	234	271	61.4	77.29	2.373	(74.80, 79.79)
99	TOTAL HC	1176	1365	117.4	91.37	0.892	(90.43, 92.30)

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RUN # D-1
MIXTURE 1

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 619
CATALYST BED TEMP RISE (DEG F) 21
MAIN HEATER TEMPERATURE (DEG F) 1020

SPACE VELOCITY 29,726
RESIDENCE TIME (SECONDS) 0.040
CATALYST BED PRESS DROP (" H2O) 8.2

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	304	255	<2.6	>98.99	0.377	
2	METHYL ETHYL KETONE	303	258	<2.2	>99.14	0.225	
3	ETHYL ACETATE	303	257	<2.2	>99.16	0.167	
4	BENZENE	305	257	5.9	97.70	0.265	(97.46, 97.95)
5	N-HEXANE	302	260	79.2	69.58	2.600	(67.18, 71.99)
99	TOTAL HC	1517	1288	92.1	92.87	0.596	(92.31, 93.42)

RUN # D-2
MIXTURE 1

CATALYST INLET TEMP (DEG F)	697	SPACE VELOCITY	29,922
CATALYST OUTLET TEMP (DEG F)	715	RESIDENCE TIME (SECONDS)	0.035
CATALYST BED TEMP RISE (DEG F)	18	CATALYST BED PRESS DROP (" H2O)	8.2
MAIN HEATER TEMPERATURE (DEG F)	1210		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	240	254	<2.0	>99.21	0.034	
2	METHYL ETHYL KETONE	239	257	<2.0	>99.22	0.034	
3	ETHYL ACETATE	240	257	<2.0	>99.22	0.034	
4	BENZENE	241	257	3.7	98.54	0.058	(98.48, 98.60)
5	N-HEXANE	238	259	14.7	94.32	0.354	(93.95, 94.69)
99	TOTAL HC	1198	1286	24.5	98.10	0.089	(98.00, 98.19)

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RUN # D-3
MIXTURE 1

CATALYST INLET TEMP (DEG F)	797	SPACE VELOCITY	49,478
CATALYST OUTLET TEMP (DEG F)	812	RESIDENCE TIME (SECONDS)	0.020
CATALYST BED TEMP RISE (DEG F)	15	CATALYST BED PRESS DROP (" H2O)	15.0
MAIN HEATER TEMPERATURE (DEG F)	1235		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	301	240	<2.0	>99.17	0.038	
2	METHYL ETHYL KETONE	300	243	<2.0	>99.18	0.036	
3	ETHYL ACETATE	301	243	<2.0	>99.18	0.035	
4	BENZENE	302	242	9.2	96.23	0.101	(96.12, 96.33)
5	N-HEXANE	299	243	31.2	87.21	0.151	(87.05, 87.37)
99	TOTAL HC	1504	1213	46.3	96.18	0.085	(96.09, 96.27)

```
RUN #     D-3H       CATALYST INLET TEMP (DEG F)           797          SPACE VELOCITY                        49,478
MIXTURE   1          CATALYST OUTLET TEMP (DEG F)          812          RESIDENCE TIME (SECONDS)               0.020
                     CATALYST BED TEMP RISE (DEG F)         15          CATALYST BED PRESS DROP (" H2O)         15.0
                     MAIN HEATER TEMPERATURE (DEG F)      1235

                                          CALCULATED       AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
SPECIES                                   INLET CONC    CONCENTRATION (PPMV-C)    ------------------------------------
 CODE          SPECIES                    (PPMV-C)      ----------------------             STD.        95% C.I.
                                                           INLET      OUTLET        MEAN    DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------------

  1          ISOPROPANOL                     301            249        72.6         70.83   0.890    ( 69.89, 71.76)
  2          METHYL ETHYL KETONE             300            252        59.0         76.58   0.715    ( 75.83, 77.33)
  3          ETHYL ACETATE                   301            251        16.7         93.35   0.191    ( 93.15, 93.55)
  4          BENZENE                         302            251       231.3          7.85   2.615    (  5.11, 10.60)
  5          N-HEXANE                        299            251       198.0         21.19   2.487    ( 18.58, 23.80)

 99          TOTAL HC                       1504           1256       577.7         53.95   1.353    ( 52.53, 55.37)

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RUN #     D-4        CATALYST INLET TEMP (DEG F)           598          SPACE VELOCITY                        49,576
MIXTURE   1          CATALYST OUTLET TEMP (DEG F)          625          RESIDENCE TIME (SECONDS)               0.023
                     CATALYST BED TEMP RISE (DEG F)         27          CATALYST BED PRESS DROP (" H2O)         15.0
                     MAIN HEATER TEMPERATURE (DEG F)       940

                                          CALCULATED       AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
SPECIES                                   INLET CONC    CONCENTRATION (PPMV-C)    ------------------------------------
 CODE          SPECIES                    (PPMV-C)      ----------------------             STD.        95% C.I.
                                                           INLET      OUTLET        MEAN    DEV.      ON THE MEAN
-----------------------------------------------------------------------------------------------------------------------

  1          ISOPROPANOL                     264            248        11.7         95.29   0.068    ( 95.22, 95.36)
  2          METHYL ETHYL KETONE             263            251         7.3         97.08   0.076    ( 97.00, 97.16)
  3          ETHYL ACETATE                   264            251         8.6         96.59   0.069    ( 96.52, 96.67)
  4          BENZENE                         265            250        11.0         95.60   0.073    ( 95.52, 95.67)
  5          N-HEXANE                        262            246        81.3         66.99   0.459    ( 66.51, 67.48)

 99          TOTAL HC                       1319           1247       119.9         90.39   0.108    ( 90.27, 90.50)
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RUN #     D-4H        CATALYST INLET TEMP (DEG F)          598            SPACE VELOCITY                         49,576
MIXTURE   1           CATALYST OUTLET TEMP (DEG F)         625            RESIDENCE TIME (SECONDS)                0.023
                      CATALYST BED TEMP RISE (DEG F)        27            CATALYST BED PRESS DROP (" H2O)         15.0
                      MAIN HEATER TEMPERATURE (DEG F)      940

                                                         AVERAGE MEASURED
                                        CALCULATED    CONCENTRATION (PPMV-C)         DESTRUCTION EFFICIENCY (%)
SPECIES                                 INLET CONC    ----------------------     ----------------------------------
 CODE         SPECIES                   (PPMV-C)        INLET      OUTLET          MEAN       STD.       95% C.I.
                                                                                             DEV.      ON THE MEAN
------------------------------------------------------------------------------------------------------------------
   1        ISOPROPANOL                    264           248        149.3          39.98     1.349    ( 38.56, 41.40)
   2        METHYL ETHYL KETONE            263           251        120.0          52.35     1.081    ( 51.21, 53.48)
   3        ETHYL ACETATE                  264           251        132.2          47.47     1.191    ( 46.22, 48.72)
   4        BENZENE                        265           250        232.8           6.89     1.720    (  5.08,  8.69)
   5        N-HEXANE                       262           245        229.0           6.60     2.368    (  4.11,  9.08)

  99        TOTAL HC                      1319          1247        863.3          30.79     1.391    ( 29.33, 32.25)

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RUN #     D-5         CATALYST INLET TEMP (DEG F)          697            SPACE VELOCITY                         49,283
MIXTURE   1           CATALYST OUTLET TEMP (DEG F)         720            RESIDENCE TIME (SECONDS)                0.021
                      CATALYST BED TEMP RISE (DEG F)        23            CATALYST BED PRESS DROP (" H2O)         15.0
                      MAIN HEATER TEMPERATURE (DEG F)     1080

                                                         AVERAGE MEASURED
                                        CALCULATED    CONCENTRATION (PPMV-C)         DESTRUCTION EFFICIENCY (%)
SPECIES                                 INLET CONC    ----------------------     ----------------------------------
 CODE         SPECIES                   (PPMV-C)        INLET      OUTLET          MEAN       STD.       95% C.I.
                                                                                             DEV.      ON THE MEAN
------------------------------------------------------------------------------------------------------------------
   1        ISOPROPANOL                    238           247          4.0          98.39     0.065    ( 98.32, 98.45)
   2        METHYL ETHYL KETONE            237           250          2.6          98.98     0.041    ( 98.94, 99.02)
   3        ETHYL ACETATE                  238           250          2.6          98.95     0.040    ( 98.91, 98.99)
   4        BENZENE                        239           250          9.5          96.22     0.135    ( 96.07, 96.36)
   5        N-HEXANE                       236           249         45.6          81.73     0.176    ( 81.54, 81.91)

  99        TOTAL HC                      1188          1248         64.3          94.85     0.046    ( 94.80, 94.90)
```

RUN # D-5H
MIXTURE 1

CATALYST INLET TEMP (DEG F)	697
CATALYST OUTLET TEMP (DEG F)	720
CATALYST BED TEMP RISE (DEG F)	23
MAIN HEATER TEMPERATURE (DEG F)	1080
SPACE VELOCITY	49,283
RESIDENCE TIME (SECONDS)	0.021
CATALYST BED PRESS DROP (" H2O)	15.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	238	239	87.0	63.64	0.820	(62.78, 64.50)
2	METHYL ETHYL KETONE	237	242	72.6	70.05	0.582	(69.44, 70.66)
3	ETHYL ACETATE	238	242	72.7	70.04	0.693	(69.32, 70.77)
4	BENZENE	239	242	224.2	7.41	1.354	(5.99, 8.83)
5	N-HEXANE	236	244	218.7	10.49	1.193	(9.24, 11.74)
99	TOTAL HC	1188	1211	675.1	44.24	0.843	(43.35, 45.12)

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RUN # D-6
MIXTURE 6

CATALYST INLET TEMP (DEG F)	599
CATALYST OUTLET TEMP (DEG F)	621
CATALYST BED TEMP RISE (DEG F)	22
MAIN HEATER TEMPERATURE (DEG F)	1020
SPACE VELOCITY	30,313
RESIDENCE TIME (SECONDS)	0.038
CATALYST BED PRESS DROP (" H2O)	8.2

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	162	158	2.5	98.44	0.056	(98.38, 98.50)
5	N-HEXANE	162	157	16.6	89.39	0.156	(89.23, 89.56)
8	TOLUENE	162	160	2.7	98.29	0.161	(98.13, 98.46)
31	N-OCTANE	163	159	4.4	97.20	0.071	(97.13, 97.28)
32	N-DECANE	162	160	2.3	98.58	0.075	(98.50, 98.66)
33	P-XYLENE	162	161	2.3	98.61	0.162	(98.44, 98.78)
34	ISOPROPYL BENZENE	162	162	2.7	98.30	0.150	(98.15, 98.46)
99	TOTAL HC	1136	1119	33.6	97.00	0.058	(96.94, 97.06)

RUN # D-7
MIXTURE 6

CATALYST INLET TEMP (DEG F) 599
CATALYST OUTLET TEMP (DEG F) 625
CATALYST BED TEMP RISE (DEG F) 26
MAIN HEATER TEMPERATURE (DEG F) 940

SPACE VELOCITY 49,381
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O) 15.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	160	157	6.4	95.93	0.100	(95.82, 96.03)
5	N-HEXANE	160	158	23.6	85.08	0.309	(84.75, 85.40)
8	TOLUENE	160	158	6.7	95.75	0.174	(95.57, 95.94)
31	N-OCTANE	161	158	8.0	94.92	0.064	(94.85, 94.99)
32	N-DECANE	160	159	5.0	96.88	0.106	(96.76, 96.99)
33	P-XYLENE	160	160	5.7	96.44	0.064	(96.37, 96.51)
34	ISOPROPYL BENZENE	161	160	6.9	95.67	0.073	(95.59, 95.75)
99	TOTAL HC	1122	1111	62.4	94.39	0.118	(94.26, 94.51)

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RUN # D-7H
MIXTURE 6

CATALYST INLET TEMP (DEG F) 599
CATALYST OUTLET TEMP (DEG F) 625
CATALYST BED TEMP RISE (DEG F) 26
MAIN HEATER TEMPERATURE (DEG F) 940

SPACE VELOCITY 49,381
RESIDENCE TIME (SECONDS) 0.023
CATALYST BED PRESS DROP (" H2O) 15.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	160	157	167.3	>6.15	2.019	
5	N-HEXANE	160	158	101.7	35.70	1.169	(34.48, 36.93)
8	TOLUENE	160	159	150.5	5.41	3.107	(2.15, 8.67)
31	N-OCTANE	161	158	53.0	66.50	0.492	(65.99, 67.02)
32	N-DECANE	160	159	46.6	70.82	0.361	(70.44, 71.20)
33	P-XYLENE	160	160	112.7	29.65	0.953	(28.65, 30.65)
34	ISOPROPYL BENZENE	161	161	115.0	28.63	1.098	(27.47, 29.78)
99	TOTAL HC	1122	1114	746.8	32.97	1.134	(31.78, 34.16)

RUN # D-8
MIXTURE 6

CATALYST INLET TEMP (DEG F) 695
CATALYST OUTLET TEMP (DEG F) 715
CATALYST BED TEMP RISE (DEG F) 20
MAIN HEATER TEMPERATURE (DEG F) 1175

SPACE VELOCITY 29,922
RESIDENCE TIME (SECONDS) 0.035
CATALYST BED PRESS DROP (" H2O) 8.2

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	164	168	2.3	98.62	0.147	(98.47, 98.78)
5	N-HEXANE	164	168	6.9	95.90	0.348	(95.54, 96.27)
8	TOLUENE	164	168	<2.1	>98.73	0.095	
31	N-OCTANE	165	168	<2.0	>98.81	0.100	
32	N-DECANE	164	166	<2.0	>98.79	0.062	
33	P-XYLENE	164	168	<2.0	>98.81	0.080	
34	ISOPROPYL BENZENE	164	168	<2.0	>98.81	0.071	
99	TOTAL HC	1149	1176	19.3	98.35	0.119	(98.23, 98.48)

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RUN # D-9
MIXTURE 6

CATALYST INLET TEMP (DEG F) 695
CATALYST OUTLET TEMP (DEG F) 718
CATALYST BED TEMP RISE (DEG F) 23
MAIN HEATER TEMPERATURE (DEG F) 1075

SPACE VELOCITY 49,772
RESIDENCE TIME (SECONDS) 0.021
CATALYST BED PRESS DROP (" H2O) 15.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
4	BENZENE	162	161	5.8	96.41	0.053	(96.35, 96.46)
5	N-HEXANE	162	161	16.3	89.93	0.174	(89.75, 90.11)
8	TOLUENE	161	162	5.4	96.68	0.274	(96.39, 96.96)
31	N-OCTANE	163	161	6.9	95.75	0.077	(95.67, 95.83)
32	N-DECANE	162	163	4.5	97.26	0.065	(97.19, 97.33)
33	P-XYLENE	162	163	4.5	97.26	0.241	(97.01, 97.52)
34	ISOPROPYL BENZENE	162	164	5.6	96.60	0.167	(96.43, 96.78)
99	TOTAL HC	1133	1137	48.8	95.70	0.116	(95.58, 95.83)

```
RUN #    D-9H      CATALYST INLET TEMP (DEG F)        695          SPACE VELOCITY                      49,772
MIXTURE  6         CATALYST OUTLET TEMP (DEG F)       718          RESIDENCE TIME (SECONDS)             0.021
                   CATALYST BED TEMP RISE (DEG F)      23          CATALYST BED PRESS DROP (" H2O)       15.0
                   MAIN HEATER TEMPERATURE (DEG F)   1075

                                                   AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                     CALCULATED  CONCENTRATION (PPMV-C)   ------------------------------------
 SPECIES                             INLET CONC  ---------------------              STD.       95% C.I.
  CODE       SPECIES                  (PPMV-C)    INLET     OUTLET          MEAN     DEV.     ON THE MEAN
-------------------------------------------------------------------------------------------------------------

   4       BENZENE                      162        154       164.0          >5.99    3.220
   5       N-HEXANE                     162        155       108.8          29.94    1.706    ( 28.14, 31.73)
   8       TOLUENE                      161        155       141.5           9.23    3.040    (  6.04, 12.42)
  31       N-OCTANE                     163        155        56.4          63.67    0.727    ( 62.90, 64.43)
  32       N-DECANE                     162        158        47.3          70.12    0.717    ( 69.36, 70.87)
  33       P-XYLENE                     162        157       100.1          36.42    1.832    ( 34.49, 38.34)
  34       ISOPROPYL BENZENE            162        158       106.8          32.40    1.932    ( 30.37, 34.43)

  99       TOTAL HC                    1133       1094       725.0          33.80    1.788    ( 31.92, 35.67)


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RUN #    E-1       CATALYST INLET TEMP (DEG F)        597          SPACE VELOCITY                      48,696
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)       631          RESIDENCE TIME (SECONDS)             0.012
                   CATALYST BED TEMP RISE (DEG F)      34          CATALYST BED PRESS DROP (" H2O)        5.9
                   MAIN HEATER TEMPERATURE (DEG F)    910

                                                   AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                     CALCULATED  CONCENTRATION (PPMV-C)   ------------------------------------
 SPECIES                             INLET CONC  ---------------------              STD.       95% C.I.
  CODE       SPECIES                  (PPMV-C)    INLET     OUTLET          MEAN     DEV.     ON THE MEAN
-------------------------------------------------------------------------------------------------------------

   1       ISOPROPANOL                  236        274        13.3          95.16    0.220    ( 94.93, 95.39)
   2       METHYL ETHYL KETONE          236        275         9.4          96.60    0.163    ( 96.43, 96.77)
   3       ETHYL ACETATE                236        272        12.0          95.61    0.223    ( 95.38, 95.85)
   4       BENZENE                      237        273        10.0          96.36    0.179    ( 96.17, 96.55)
   5       N-HEXANE                     235        277        47.1          82.98    0.519    ( 82.44, 83.53)

  99       TOTAL HC                    1180       1374        91.7          93.32    0.263    ( 93.05, 93.60)
```

RUN # E-1C
MIXTURE 1

CATALYST INLET TEMP (DEG F)	597
CATALYST OUTLET TEMP (DEG F)	631
CATALYST BED TEMP RISE (DEG F)	34
MAIN HEATER TEMPERATURE (DEG F)	910
SPACE VELOCITY	48,696
RESIDENCE TIME (SECONDS)	0.012
CATALYST BED PRESS DROP (" H2O)	5.9

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	236	219	11.6	94.75	0.906	(93.80, 95.70)
2	METHYL ETHYL KETONE	236	192	8.2	95.80	0.799	(94.96, 96.63)
3	ETHYL ACETATE	236	203	10.3	94.98	0.979	(93.96, 96.01)
4	BENZENE	237	263	8.9	96.66	0.519	(96.11, 97.20)
5	N-HEXANE	235	263	40.8	84.65	2.417	(82.11, 87.18)
99	TOTAL HC	1180	1142	79.8	93.07	1.159	(91.86, 94.29)

RUN # E-2
MIXTURE 1

CATALYST INLET TEMP (DEG F)	698
CATALYST OUTLET TEMP (DEG F)	717
CATALYST BED TEMP RISE (DEG F)	19
MAIN HEATER TEMPERATURE (DEG F)	1075
SPACE VELOCITY	29,237
RESIDENCE TIME (SECONDS)	0.017
CATALYST BED PRESS DROP (" H2O)	3.9

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	250	260	<2.0	>99.23	0.029	
2	METHYL ETHYL KETONE	249	262	<2.0	>99.24	0.028	
3	ETHYL ACETATE	249	259	<2.0	>99.23	0.030	
4	BENZENE	251	261	4.2	98.39	0.073	(98.32, 98.46)
5	N-HEXANE	248	267	16.1	93.97	0.211	(93.77, 94.16)
99	TOTAL HC	1247	1311	26.4	97.99	0.045	(97.95, 98.03)

```
RUN #    E-2C      CATALYST INLET TEMP (DEG F)          698          SPACE VELOCITY                      29,237
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)         717          RESIDENCE TIME (SECONDS)             0.017
                   CATALYST BED TEMP RISE (DEG F)        19          CATALYST BED PRESS DROP (" H2O)        3.9
                   MAIN HEATER TEMPERATURE (DEG F)     1075

                                                     AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                      CALCULATED    CONCENTRATION (PPMV-C)      -----------------------------------
SPECIES                               INLET CONC    ----------------------                STD.       95% C.I.
 CODE         SPECIES                  (PPMV-C)        INLET     OUTLET          MEAN     DEV.     ON THE MEAN
--------------------------------------------------------------------------------------------------------------

  1         ISOPROPANOL                  250            118       <2.0          >98.32    0.061
  2         METHYL ETHYL KETONE          249             99       <2.0          >97.98    0.075
  3         ETHYL ACETATE                249            104       <2.0          >98.08    0.073
  4         BENZENE                      251            257        4.3           98.33    0.163   ( 98.16, 98.50)
  5         N-HEXANE                     248            258       16.2           93.72    0.473   ( 93.22, 94.21)

 99         TOTAL HC                    1247            838       26.5           96.83    0.213   ( 96.61, 97.06)


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RUN #    E-3       CATALYST INLET TEMP (DEG F)          600          SPACE VELOCITY                      29,335
MIXTURE  1         CATALYST OUTLET TEMP (DEG F)         627          RESIDENCE TIME (SECONDS)             0.019
                   CATALYST BED TEMP RISE (DEG F)        27          CATALYST BED PRESS DROP (" H2O)        3.1
                   MAIN HEATER TEMPERATURE (DEG F)      934

                                                     AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                      CALCULATED    CONCENTRATION (PPMV-C)      -----------------------------------
SPECIES                               INLET CONC    ----------------------                STD.       95% C.I.
 CODE         SPECIES                  (PPMV-C)        INLET     OUTLET          MEAN     DEV.     ON THE MEAN
--------------------------------------------------------------------------------------------------------------

  1         ISOPROPANOL                  240            246        5.5           97.78    0.072   ( 97.71, 97.86)
  2         METHYL ETHYL KETONE          239            245        3.9           98.41    0.083   ( 98.32, 98.50)
  3         ETHYL ACETATE                239            246        4.8           98.07    0.123   ( 97.94, 98.20)
  4         BENZENE                      240            247        5.7           97.70    0.133   ( 97.56, 97.84)
  5         N-HEXANE                     238            248       35.6           85.66    0.430   ( 85.21, 86.11)

 99         TOTAL HC                    1196           1233       55.5           95.51    0.153   ( 95.34, 95.67)
```

RUN # E-3C
MIXTURE 1

CATALYST INLET TEMP (DEG F) 600
CATALYST OUTLET TEMP (DEG F) 627
CATALYST BED TEMP RISE (DEG F) 27
MAIN HEATER TEMPERATURE (DEG F) 934

SPACE VELOCITY 29,335
RESIDENCE TIME (SECONDS) 0.019
CATALYST BED PRESS DROP (" H2O) 3.1

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	240	183	5.3	97.12	0.164	(96.96, 97.27)
2	METHYL ETHYL KETONE	239	145	3.5	97.56	0.221	(97.36, 97.77)
3	ETHYL ACETATE	239	155	4.5	97.09	0.289	(96.82, 97.36)
4	BENZENE	240	240	5.5	97.70	0.119	(97.59, 97.81)
5	N-HEXANE	238	241	32.8	86.43	0.595	(85.88, 86.98)
99	TOTAL HC	1196	966	51.7	94.65	0.265	(94.41, 94.90)

RUN # E-4
MIXTURE 1

CATALYST INLET TEMP (DEG F) 798
CATALYST OUTLET TEMP (DEG F) 812
CATALYST BED TEMP RISE (DEG F) 14
MAIN HEATER TEMPERATURE (DEG F) 1220

SPACE VELOCITY 29,188
RESIDENCE TIME (SECONDS) 0.016
CATALYST BED PRESS DROP (" H2O) 3.6

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	256	266	<2.0	>99.25	0.020	
2	METHYL ETHYL KETONE	255	267	<2.0	>99.25	0.020	
3	ETHYL ACETATE	255	264	<2.0	>99.24	0.021	
4	BENZENE	257	266	3.0	98.87	0.140	(98.73, 99.02)
5	N-HEXANE	254	271	8.6	96.85	0.278	(96.56, 97.14)
99	TOTAL HC	1277	1336	17.6	98.69	0.088	(98.59, 98.78)

RUN # E-4C
MIXTURE 1

CATALYST INLET TEMP (DEG F) 798
CATALYST OUTLET TEMP (DEG F) 812
CATALYST BED TEMP RISE (DEG F) 14
MAIN HEATER TEMPERATURE (DEG F) 1220

SPACE VELOCITY 29,188
RESIDENCE TIME (SECONDS) 0.016
CATALYST BED PRESS DROP (" H2O) 3.6

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	256	96	<2.0	>97.92	0.030	
2	METHYL ETHYL KETONE	255	81	<2.0	>97.55	0.028	
3	ETHYL ACETATE	255	46	<2.0	>95.67	0.059	
4	BENZENE	257	263	3.5	98.69	0.137	(98.54, 98.83)
5	N-HEXANE	254	243	9.7	96.00	0.212	(95.78, 96.22)
99	TOTAL HC	1277	730	19.2	97.37	0.114	(97.25, 97.49)

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RUN # E-5
MIXTURE 1

CATALYST INLET TEMP (DEG F) 600
CATALYST OUTLET TEMP (DEG F) 617
CATALYST BED TEMP RISE (DEG F) 17
MAIN HEATER TEMPERATURE (DEG F) 995

SPACE VELOCITY 19,459
RESIDENCE TIME (SECONDS) 0.029
CATALYST BED PRESS DROP (" H2O) 1.9

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	243	246	<2.0	>99.19	0.038	
2	METHYL ETHYL KETONE	242	246	<2.0	>99.19	0.038	
3	ETHYL ACETATE	242	246	<2.0	>99.19	0.038	
4	BENZENE	244	247	2.4	99.01	0.078	(98.94, 99.08)
5	N-HEXANE	241	248	19.5	92.12	0.130	(92.00, 92.24)
99	TOTAL HC	1212	1235	28.0	97.73	0.052	(97.68, 97.78)

RUN # E-5C
MIXTURE 1

CATALYST INLET TEMP (DEG F) 600
CATALYST OUTLET TEMP (DEG F) 617
CATALYST BED TEMP RISE (DEG F) 17
MAIN HEATER TEMPERATURE (DEG F) 995

SPACE VELOCITY 19,459
RESIDENCE TIME (SECONDS) 0.029
CATALYST BED PRESS DROP (" H2O) 1.9

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	243	135	<2.0	>98.52	0.060	
2	METHYL ETHYL KETONE	242	101	<2.0	>98.03	0.080	
3	ETHYL ACETATE	242	109	<2.0	>98.17	0.077	
4	BENZENE	244	251	2.3	99.08	0.091	(98.99, 99.16)
5	N-HEXANE	241	251	19.1	92.38	0.301	(92.10, 92.66)
99	TOTAL HC	1212	849	27.4	96.77	0.109	(96.67, 96.87)

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RUN # E-6
MIXTURE 1

CATALYST INLET TEMP (DEG F) 699
CATALYST OUTLET TEMP (DEG F) 706
CATALYST BED TEMP RISE (DEG F) 7
MAIN HEATER TEMPERATURE (DEG F) 1120

SPACE VELOCITY 19,459
RESIDENCE TIME (SECONDS) 0.027
CATALYST BED PRESS DROP (" H2O) 2.7

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	238	253	<2.0	>99.21	0.014	
2	METHYL ETHYL KETONE	237	254	<2.0	>99.21	0.014	
3	ETHYL ACETATE	237	251	<2.0	>99.21	0.015	
4	BENZENE	238	253	<2.0	>99.21	0.015	
5	N-HEXANE	236	257	7.2	97.20	0.049	(97.15, 97.25)
99	TOTAL HC	1186	1271	15.2	98.80	0.014	(98.79, 98.82)

RUN # E-6C
MIXTURE 1

CATALYST INLET TEMP (DEG F) 699
CATALYST OUTLET TEMP (DEG F) 706
CATALYST BED TEMP RISE (DEG F) 7
MAIN HEATER TEMPERATURE (DEG F) 1120

SPACE VELOCITY 19,459
RESIDENCE TIME (SECONDS) 0.027
CATALYST BED PRESS DROP (" H2O) 2.7

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	238	74	<2.0	>97.32	0.092	
2	METHYL ETHYL KETONE	237	60	<2.0	>96.70	0.106	
3	ETHYL ACETATE	237	37	<2.0	>94.68	0.370	
4	BENZENE	238	246	<2.0	>99.19	0.025	
5	N-HEXANE	236	234	7.0	97.00	0.263	(96.73, 97.28)
99	TOTAL HC	1186	653	15.0	97.70	0.116	(97.58, 97.82)

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RUN # E-7
MIXTURE 1

CATALYST INLET TEMP (DEG F) 597
CATALYST OUTLET TEMP (DEG F) 611
CATALYST BED TEMP RISE (DEG F) 14
MAIN HEATER TEMPERATURE (DEG F) 1032

SPACE VELOCITY 14,668
RESIDENCE TIME (SECONDS) 0.040
CATALYST BED PRESS DROP (" H2O) 1.8

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	246	284	<2.0	>99.29	0.057	
2	METHYL ETHYL KETONE	245	286	<2.0	>99.30	0.058	
3	ETHYL ACETATE	246	282	<2.0	>99.29	0.060	
4	BENZENE	247	283	<2.0	>99.29	0.058	
5	N-HEXANE	244	286	8.7	96.93	0.233	(96.69, 97.18)
99	TOTAL HC	1228	1422	16.7	98.82	0.085	(98.73, 98.91)

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RUN #    E-7C       CATALYST INLET TEMP (DEG F)          597          SPACE VELOCITY                       14,668
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)         611          RESIDENCE TIME (SECONDS)              0.040
                    CATALYST BED TEMP RISE (DEG F)        14          CATALYST BED PRESS DROP (" H2O)         1.8
                    MAIN HEATER TEMPERATURE (DEG F)     1032

                                                     AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)    -----------------------------------
 SPECIES                               INLET CONC   ----------------------                STD.        95% C.I.
  CODE       SPECIES                   (PPMV-C)       INLET      OUTLET        MEAN       DEV.      ON THE MEAN
---------------------------------------------------------------------------------------------------------------

    1       ISOPROPANOL                   246            87        <2.0        >97.70     0.115
    2       METHYL ETHYL KETONE           245            68        <2.0        >97.08     0.138
    3       ETHYL ACETATE                 246            64        <2.0        >96.87     0.359
    4       BENZENE                       247           287        <2.0        >99.30     0.017
    5       N-HEXANE                      244           278         8.9         96.82     0.129    ( 96.68, 96.95)

   99       TOTAL HC                     1228           786        16.9         97.85     0.076    ( 97.77, 97.93)


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RUN #    E-8        CATALYST INLET TEMP (DEG F)          598          SPACE VELOCITY                       29,335
MIXTURE  1          CATALYST OUTLET TEMP (DEG F)         628          RESIDENCE TIME (SECONDS)              0.020
                    CATALYST BED TEMP RISE (DEG F)        30          CATALYST BED PRESS DROP (" H2O)         3.5
                    MAIN HEATER TEMPERATURE (DEG F)      925

                                                     AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)    -----------------------------------
 SPECIES                               INLET CONC   ----------------------                STD.        95% C.I.
  CODE       SPECIES                   (PPMV-C)       INLET      OUTLET        MEAN       DEV.      ON THE MEAN
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    1       ISOPROPANOL                   240           286         4.9         98.30     0.340    ( 97.95, 98.66)
    2       METHYL ETHYL KETONE           240           288         3.5         98.79     0.318    ( 98.46, 99.13)
    3       ETHYL ACETATE                 240           284         4.5         98.44     0.332    ( 98.09, 98.78)
    4       BENZENE                       241           286         5.1         98.23     0.189    ( 98.03, 98.43)
    5       N-HEXANE                      239           286        27.2         90.50     0.120    ( 90.38, 90.63)

   99       TOTAL HC                     1200          1432        45.1         96.86     0.253    ( 96.59, 97.12)
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RUN # E-8C
MIXTURE 1

CATALYST INLET TEMP (DEG F) 598
CATALYST OUTLET TEMP (DEG F) 628
CATALYST BED TEMP RISE (DEG F) 30
MAIN HEATER TEMPERATURE (DEG F) 925

SPACE VELOCITY 29,335
RESIDENCE TIME (SECONDS) 0.020
CATALYST BED PRESS DROP (" H2O) 3.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	240	198	4.9	97.51	0.467	(97.02, 98.00)
2	METHYL ETHYL KETONE	240	164	3.3	98.02	0.552	(97.44, 98.60)
3	ETHYL ACETATE	240	178	4.2	97.68	0.506	(97.15, 98.21)
4	BENZENE	241	283	4.9	98.26	0.184	(98.07, 98.45)
5	N-HEXANE	239	285	26.8	90.62	0.230	(90.38, 90.87)
99	TOTAL HC	1200	1109	44.1	96.03	0.328	(95.69, 96.37)

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RUN # E-9C
MIXTURE 3

CATALYST INLET TEMP (DEG F) 793
CATALYST OUTLET TEMP (DEG F) 803
CATALYST BED TEMP RISE (DEG F) 10
MAIN HEATER TEMPERATURE (DEG F) 1020

SPACE VELOCITY 19,312
RESIDENCE TIME (SECONDS) 0.025
CATALYST BED PRESS DROP (" H2O) 3.6

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	184	<113	<2.0	98.13	0.590	(96.67, 99.59)
3	ETHYL ACETATE	183	31	<2.0	>93.56	0.321	
9	METHANOL	183	49	<2.0	>95.98	0.238	
10	ETHANOL	184	47	<2.0	>95.73	0.268	
12	N-BUTANOL	184	40	<2.0	>95.09	0.359	
14	N-PROPYL ACETATE	184	34	<2.0	>94.21	0.231	
15	ISOBUTYL ACETATE	183	46	<2.0	>95.73	0.164	
99	TOTAL HC	1286	364	14.0	96.12	0.415	(95.09, 97.15)

RUN # E-10
MIXTURE 3

CATALYST INLET TEMP (DEG F) 600
CATALYST OUTLET TEMP (DEG F) 606
CATALYST BED TEMP RISE (DEG F) 6
MAIN HEATER TEMPERATURE (DEG F) 1040

SPACE VELOCITY 14,521
RESIDENCE TIME (SECONDS) 0.040
CATALYST BED PRESS DROP (" H2O) 1.9

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	184	175	<2.0	>98.86	0.037	
3	ETHYL ACETATE	183	176	<2.0	>98.87	0.026	
9	METHANOL	184	178	<2.0	>98.88	0.038	
10	ETHANOL	184	177	<2.0	>98.87	0.036	
12	N-BUTANOL	184	171	<2.0	>98.83	0.031	
14	N-PROPYL ACETATE	184	179	<2.0	>98.88	0.032	
15	ISOBUTYL ACETATE	183	177	<2.0	>98.87	0.035	
99	TOTAL HC	1288	1235	14.0	98.87	0.033	(98.78, 98.95)

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RUN # E-10C
MIXTURE 3

CATALYST INLET TEMP (DEG F) 600
CATALYST OUTLET TEMP (DEG F) 606
CATALYST BED TEMP RISE (DEG F) 6
MAIN HEATER TEMPERATURE (DEG F) 1040

SPACE VELOCITY 14,521
RESIDENCE TIME (SECONDS) 0.040
CATALYST BED PRESS DROP (" H2O) 1.9

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	184	39	<2.0	>94.83	0.511	
3	ETHYL ACETATE	183	45	<2.0	>95.60	0.264	
9	METHANOL	184	45	<2.0	>95.62	0.264	
10	ETHANOL	184	41	<2.0	>95.19	0.297	
12	N-BUTANOL	184	32	<2.0	>93.74	0.381	
14	N-PROPYL ACETATE	184	45	<2.0	>95.59	0.284	
15	ISOBUTYL ACETATE	183	47	<2.0	>95.72	0.356	
99	TOTAL HC	1288	296	14.0	95.26	0.328	(94.74, 95.78)

RUN # E-11
MIXTURE 3

CATALYST INLET TEMP (DEG F) 699
CATALYST OUTLET TEMP (DEG F) 704
CATALYST BED TEMP RISE (DEG F) 5
MAIN HEATER TEMPERATURE (DEG F) 1120

SPACE VELOCITY 19,361
RESIDENCE TIME (SECONDS) 0.027
CATALYST BED PRESS DROP (" H2O) 1.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	184	156	<2.0	>98.72	0.046	
3	ETHYL ACETATE	183	155	<2.0	>98.71	0.033	
9	METHANOL	183	160	<2.0	>98.75	0.047	
10	ETHANOL	184	158	<2.0	>98.74	0.046	
12	N-BUTANOL	183	151	<2.0	>98.68	0.063	
14	N-PROPYL ACETATE	183	162	<2.0	>98.76	0.045	
15	ISOBUTYL ACETATE	183	161	<2.0	>98.76	0.046	
99	TOTAL HC	1283	1105	14.0	98.73	0.046	(98.62, 98.85)

RUN # E-11C
MIXTURE 3

CATALYST INLET TEMP (DEG F) 699
CATALYST OUTLET TEMP (DEG F) 704
CATALYST BED TEMP RISE (DEG F) 5
MAIN HEATER TEMPERATURE (DEG F) 1120

SPACE VELOCITY 19,361
RESIDENCE TIME (SECONDS) 0.027
CATALYST BED PRESS DROP (" H2O) 1.5

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	184	<89	<2.0	97.66	0.607	(96.15, 99.16)
3	ETHYL ACETATE	183	35	<2.0	>94.40	0.087	
9	METHANOL	183	46	<2.0	>95.73	0.127	
10	ETHANOL	184	43	<2.0	>95.41	0.142	
12	N-BUTANOL	183	36	<2.0	>94.44	0.141	
14	N-PROPYL ACETATE	183	37	<2.0	>94.69	0.162	
15	ISOBUTYL ACETATE	183	46	<2.0	>95.69	0.152	
99	TOTAL HC	1283	336	14.0	95.82	0.343	(94.96, 96.67)

RUN # E-12
MIXTURE 1

CATALYST INLET TEMP (DEG F)	598	SPACE VELOCITY	29,188
CATALYST OUTLET TEMP (DEG F)	626	RESIDENCE TIME (SECONDS)	0.020
CATALYST BED TEMP RISE (DEG F)	28	CATALYST BED PRESS DROP (" H2O)	3.5
MAIN HEATER TEMPERATURE (DEG F)	925		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
1	ISOPROPANOL	241	254	5.3	97.90	0.164	(97.73, 98.07)
2	METHYL ETHYL KETONE	241	255	3.8	98.52	0.053	(98.46, 98.57)
3	ETHYL ACETATE	241	251	5.0	98.02	0.059	(97.96, 98.08)
4	BENZENE	242	254	5.0	98.04	0.027	(98.01, 98.06)
5	N-HEXANE	240	260	30.1	88.45	0.064	(88.38, 88.51)
99	TOTAL HC	1205	1276	49.2	96.14	0.046	(96.10, 96.19)

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RUN # E-12C
MIXTURE 1

CATALYST INLET TEMP (DEG F)	598	SPACE VELOCITY	29,188
CATALYST OUTLET TEMP (DEG F)	626	RESIDENCE TIME (SECONDS)	0.020
CATALYST BED TEMP RISE (DEG F)	28	CATALYST BED PRESS DROP (" H2O)	3.5
MAIN HEATER TEMPERATURE (DEG F)	925		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C) INLET	AVERAGE MEASURED CONCENTRATION (PPMV-C) OUTLET	DESTRUCTION EFFICIENCY (%) MEAN	DESTRUCTION EFFICIENCY (%) STD. DEV.	DESTRUCTION EFFICIENCY (%) 95% C.I. ON THE MEAN
1	ISOPROPANOL	241	186	5.1	97.28	0.492	(96.76, 97.79)
2	METHYL ETHYL KETONE	241	156	3.6	97.70	0.324	(97.36, 98.04)
3	ETHYL ACETATE	241	168	4.8	97.20	0.416	(96.76, 97.63)
4	BENZENE	242	249	4.7	98.10	0.180	(97.92, 98.29)
5	N-HEXANE	240	254	28.3	88.91	1.110	(87.75, 90.08)
99	TOTAL HC	1205	1015	46.5	95.43	0.473	(94.94, 95.93)

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RUN #    E-13C      CATALYST INLET TEMP (DEG F)          798          SPACE VELOCITY                          29,384
MIXTURE  4          CATALYST OUTLET TEMP (DEG F)         804          RESIDENCE TIME (SECONDS)                 0.017
                    CATALYST BED TEMP RISE (DEG F)         6          CATALYST BED PRESS DROP (" H2O)            3.6
                    MAIN HEATER TEMPERATURE (DEG F)     1210

                                                       AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                        CALCULATED   CONCENTRATION (PPMV-C)   -----------------------------------
SPECIES                                 INLET CONC   ----------------------               STD.        95% C.I.
 CODE        SPECIES                     (PPMV-C)        INLET      OUTLET         MEAN    DEV.      ON THE MEAN
---------------------------------------------------------------------------------------------------------------

  2        METHYL ETHYL KETONE            168             62         <2.0         >96.78   0.307
 16        ACETONE                        167             92         <2.0         >97.84   0.177
 17        METHYL ISOBUTYL KETONE         168             54         <2.0         >96.32   0.340
 18        CYCLOHEXANONE                  168             33         <2.0         >93.91   0.579
 22        ETHYL CELLOSOLVE               168             29         <2.0         >93.23   0.881
 23        BUTYL CELLUSOLVE               168             41         <2.0         >95.15   0.242
 24        DIOXANE                        168            118         <2.0         >98.30   0.144

 99        TOTAL HC                      1174            432         14.0          96.75   0.277    ( 96.06, 97.43)


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RUN #    E-14       CATALYST INLET TEMP (DEG F)          595          SPACE VELOCITY                         145,697
MIXTURE  4          CATALYST OUTLET TEMP (DEG F)         608          RESIDENCE TIME (SECONDS)                 0.004
                    CATALYST BED TEMP RISE (DEG F)        13          CATALYST BED PRESS DROP (" H2O)            1.2
                    MAIN HEATER TEMPERATURE (DEG F)     1030

                                                       AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                        CALCULATED   CONCENTRATION (PPMV-C)   -----------------------------------
SPECIES                                 INLET CONC   ----------------------               STD.        95% C.I.
 CODE        SPECIES                     (PPMV-C)        INLET      OUTLET         MEAN    DEV.      ON THE MEAN
---------------------------------------------------------------------------------------------------------------

  2        METHYL ETHYL KETONE            175            185         <2.0         >98.92   0.043
 16        ACETONE                        174            186         <2.0         >98.92   0.046
 17        METHYL ISOBUTYL KETONE         175            180         <2.0         >98.89   0.045
 18        CYCLOHEXANONE                  175            181         <2.0         >98.89   0.035
 22        ETHYL CELLOSOLVE               175            190         <2.0         >98.95   0.035
 23        BUTYL CELLUSOLVE               175            174         <2.0         >98.85   0.017
 24        DIOXANE                        175            180         <2.0         >98.89   0.045

 99        TOTAL HC                      1224           1278         14.0          98.90   0.038    ( 98.84, 98.96)
```

RUN # E-14C
MIXTURE 4

CATALYST INLET TEMP (DEG F) 595
CATALYST OUTLET TEMP (DEG F) 608
CATALYST BED TEMP RISE (DEG F) 13
MAIN HEATER TEMPERATURE (DEG F) 1030

SPACE VELOCITY 145,697
RESIDENCE TIME (SECONDS) 0.004
CATALYST BED PRESS DROP (" H2O) 1.2

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	175	72	<2.0	>97.21	0.239	
16	ACETONE	174	105	<2.0	>98.10	0.123	
17	METHYL ISOBUTYL KETONE	175	63	<2.0	>96.83	0.247	
18	CYCLOHEXANONE	175	38	<2.0	>94.81	0.324	
22	ETHYL CELLOSOLVE	175	35	<2.0	>94.39	0.206	
23	BUTYL CELLUSOLVE	175	47	<2.0	>95.71	0.628	
24	DIOXANE	175	156	<2.0	>98.71	0.078	
99	TOTAL HC	1224	518	14.0	97.29	0.161	(96.89, 97.69)

RUN # E-15
MIXTURE 4

CATALYST INLET TEMP (DEG F) 697
CATALYST OUTLET TEMP (DEG F) 705
CATALYST BED TEMP RISE (DEG F) 8
MAIN HEATER TEMPERATURE (DEG F) 1098

SPACE VELOCITY 19,899
RESIDENCE TIME (SECONDS) 0.027
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
2	METHYL ETHYL KETONE	175	187	<2.0	>98.93	0.011	
16	ACETONE	174	188	<2.0	>98.94	0.015	
17	METHYL ISOBUTYL KETONE	175	179	<2.0	>98.88	0.016	
18	CYCLOHEXANONE	175	178	<2.0	>98.88	0.027	
22	ETHYL CELLOSOLVE	174	187	<2.0	>98.93	0.037	
23	BUTYL CELLUSOLVE	175	169	<2.0	>98.82	0.025	
24	DIOXANE	175	179	<2.0	>98.89	0.018	
99	TOTAL HC	1223	1268	14.0	98.90	0.019	(98.85, 98.94)

```
RUN #    E-15C      CATALYST INLET TEMP (DEG F)         697          SPACE VELOCITY                       19,899
MIXTURE  4          CATALYST OUTLET TEMP (DEG F)        705          RESIDENCE TIME (SECONDS)              0.027
                    CATALYST BED TEMP RISE (DEG F)        8          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)    1098

                                                         AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)    -----------------------------------
 SPECIES                                 INLET CONC   ----------------------                 STD.       95% C.I.
  CODE         SPECIES                    (PPMV-C)      INLET      OUTLET         MEAN       DEV.     ON THE MEAN
-------------------------------------------------------------------------------------------------------------------

   2        METHYL ETHYL KETONE             175            67        <2.0         >97.03     0.076
  16        ACETONE                         174            98        <2.0         >97.97     0.072
  17        METHYL ISOBUTYL KETONE          175            61        <2.0         >96.73     0.124
  18        CYCLOHEXANONE                   175            39        <2.0         >94.97     0.161
  22        ETHYL CELLOSOLVE                174            36        <2.0         >94.57     0.132
  23        BUTYL CELLUSOLVE                175            49        <2.0         >95.98     0.220
  24        DIOXANE                         175           144        <2.0         >98.61     0.034

  99        TOTAL HC                       1223           498        14.0          97.19     0.057    ( 97.05, 97.33)


==========================================================================================================================


RUN #    E-16C      CATALYST INLET TEMP (DEG F)         797          SPACE VELOCITY                       29,139
MIXTURE  6          CATALYST OUTLET TEMP (DEG F)        810          RESIDENCE TIME (SECONDS)              0.017
                    CATALYST BED TEMP RISE (DEG F)       13          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)    1210

                                                         AVERAGE MEASURED            DESTRUCTION EFFICIENCY (%)
                                         CALCULATED   CONCENTRATION (PPMV-C)    -----------------------------------
 SPECIES                                 INLET CONC   ----------------------                 STD.       95% C.I.
  CODE         SPECIES                    (PPMV-C)      INLET      OUTLET         MEAN       DEV.     ON THE MEAN
-------------------------------------------------------------------------------------------------------------------

   4        BENZENE                         181           174         3.1          98.23     0.102    ( 98.12, 98.33)
   5        N-HEXANE                        181            49        <5.0         >89.88     1.844
   8        TOLUENE                         181           144        <2.7         >98.17     0.360
  31        N-OCTANE                        182            58         2.9          95.09     1.086    ( 93.95, 96.23)
  32        N-DECANE                        181            46         3.2          93.18     1.994    ( 91.09, 95.27)
  33        P-XYLENE                        181            96        <2.2         >97.68     0.512
  34        ISOPROPYL BENZENE               181           104        <2.4         >97.74     0.437

  99        TOTAL HC                       1267           674        21.4          96.83     0.276    ( 96.54, 97.12)
```

```
RUN #    E-17        CATALYST INLET TEMP (DEG F)          602          SPACE VELOCITY                     14,765
MIXTURE  6           CATALYST OUTLET TEMP (DEG F)         616          RESIDENCE TIME (SECONDS)            0.039
                     CATALYST BED TEMP RISE (DEG F)        14          CATALYST BED PRESS DROP (" H2O)
                     MAIN HEATER TEMPERATURE (DEG F)     1015

                                                      AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                               INLET CONC   ----------------------               STD.        95% C.I.
 CODE        SPECIES                  (PPMV-C)       INLET      OUTLET         MEAN     DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

  4        BENZENE                       164          167        <3.2         >98.08   0.729
  5        N-HEXANE                      164          148        <7.2         >95.10   1.573
  8        TOLUENE                       164          162        <2.5         >98.44   0.521
 31        N-OCTANE                      165          162        <3.4         >97.89   0.648
 32        N-DECANE                      164          163        <5.3         >96.76   1.770
 33        P-XYLENE                      164          162        <2.2         >98.66   0.275
 34        ISOPROPYL BENZENE             165          157        <2.0         >98.73   0.012

 99        TOTAL HC                     1151         1123        25.8          97.70   0.731    ( 96.93, 98.46)


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RUN #    E-17C       CATALYST INLET TEMP (DEG F)          602          SPACE VELOCITY                     14,765
MIXTURE  6           CATALYST OUTLET TEMP (DEG F)         616          RESIDENCE TIME (SECONDS)            0.039
                     CATALYST BED TEMP RISE (DEG F)        14          CATALYST BED PRESS DROP (" H2O)
                     MAIN HEATER TEMPERATURE (DEG F)     1015

                                                      AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                      CALCULATED   CONCENTRATION (PPMV-C)    -----------------------------------
 ECIES                                INLET CONC   ----------------------               STD.        95% C.I.
  ODE        SPECIES                  (PPMV-C)       INLET      OUTLET         MEAN     DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

  4        BENZENE                       164          163        <2.9         >98.24   0.843
  5        N-HEXANE                      164          108        <7.7         >92.89   2.310
  8        TOLUENE                       164          141        <3.5         >97.48   2.006
 31        N-OCTANE                      165           55        <2.9         >94.83   2.135
 32        N-DECANE                      164           46        <4.0         >91.34   6.162
 33        P-XYLENE                      164           99        <2.0         >97.94   0.147
 34        ISOPROPYL BENZENE             165          104        <2.1         >97.99   0.215

 99        TOTAL HC                     1151          719        25.1          96.50   1.471    ( 94.96, 98.05)
```

```
RUN #     E-18      CATALYST INLET TEMP (DEG F)          697          SPACE VELOCITY                      19,410
MIXTURE   6         CATALYST OUTLET TEMP (DEG F)         710          RESIDENCE TIME (SECONDS)             0.027
                    CATALYST BED TEMP RISE (DEG F)        13          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)     1090

                                                      AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)     -----------------------------------
SPECIES                                INLET CONC   ----------------------                 STD.        95% C.I.
 CODE        SPECIES                    (PPMV-C)      INLET      OUTLET          MEAN      DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------------

  4       BENZENE                          162          163        <2.8         >98.27    0.816
  5       N-HEXANE                         162          152        <7.2         >95.23    1.568
  8       TOLUENE                          162          158        <2.6         >98.34    0.754
 31       N-OCTANE                         163          158        <2.8         >98.23    0.561
 32       N-DECANE                         162          159        <3.5         >97.81    0.871
 33       P-XYLENE                         162          159        <2.3         >98.57    0.306
 34       ISOPROPYL BENZENE                162          153        <2.2         >98.59    0.201

 99       TOTAL HC                        1136         1106        23.4          97.88    0.640   ( 97.21, 98.56)


=================================================================================================================


RUN #     E-18C     CATALYST INLET TEMP (DEG F)          697          SPACE VELOCITY                      19,410
MIXTURE   6         CATALYST OUTLET TEMP (DEG F)         710          RESIDENCE TIME (SECONDS)             0.027
                    CATALYST BED TEMP RISE (DEG F)        13          CATALYST BED PRESS DROP (" H2O)
                    MAIN HEATER TEMPERATURE (DEG F)     1090

                                                      AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                       CALCULATED   CONCENTRATION (PPMV-C)     -----------------------------------
SPECIES                                INLET CONC   ----------------------                 STD.        95% C.I.
 CODE        SPECIES                    (PPMV-C)      INLET      OUTLET          MEAN      DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------------

  4       BENZENE                          162          169         3.3          98.03    0.698   ( 97.29, 98.76)
  5       N-HEXANE                         162          118        <8.0         >93.19    2.027
  8       TOLUENE                          162          144        <2.7         >98.11    0.729
 31       N-OCTANE                         163           58        <3.2         >94.50    1.694
 32       N-DECANE                         162           47        <4.5         >90.52    4.695
 33       P-XYLENE                         162           97        <2.1         >97.80    0.705
 34       ISOPROPYL BENZENE                162          104        <2.1         >97.98    0.211

 99       TOTAL HC                        1136          739        26.0          96.48    0.699   ( 95.74, 97.21)
```

RUN # E-19C
MIXTURE 1

CATALYST INLET TEMP (DEG F) 797
CATALYST OUTLET TEMP (DEG F) 818
CATALYST BED TEMP RISE (DEG F) 21
MAIN HEATER TEMPERATURE (DEG F) 1080

SPACE VELOCITY 48,745
RESIDENCE TIME (SECONDS) 0.010
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
1	ISOPROPANOL	240	152	4.4	97.11	0.657	(96.42, 97.80)
2	METHYL ETHYL KETONE	239	132	3.6	97.31	0.520	(96.76, 97.85)
3	ETHYL ACETATE	239	129	3.7	97.13	0.797	(96.30, 97.97)
4	BENZENE	241	292	8.8	97.01	0.211	(96.79, 97.23)
5	N-HEXANE	238	283	22.1	92.21	0.208	(91.99, 92.43)
99	TOTAL HC	1197	991	42.5	95.71	0.322	(95.37, 96.05)

===

RUN # F-1
MIXTURE 25

CATALYST INLET TEMP (DEG F) 504
CATALYST OUTLET TEMP (DEG F) 845
CATALYST BED TEMP RISE (DEG F) 341
MAIN HEATER TEMPERATURE (DEG F) 750

SPACE VELOCITY 46,447
RESIDENCE TIME (SECONDS) 0.012
CATALYST BED PRESS DROP (" H2O) 11.0

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
53	ETHANE		1642	167.0	89.83	0.854	(87.71, 91.95)
54	ETHYLENE		8109	<2.0	>99.98	0.000	
55	ETHYLENE OXIDE		214	<2.0	>99.07	0.011	
98	TOTAL VOC		8323	4.0	99.95	0.000	(99.95, 99.95)
99	TOTAL HC		9965	171.0	98.28	0.138	(97.94, 98.63)

```
RUN #    F-1C        CATALYST INLET TEMP (DEG F)          504          SPACE VELOCITY                       46,447
MIXTURE  25          CATALYST OUTLET TEMP (DEG F)         845          RESIDENCE TIME (SECONDS)              0.012
                     CATALYST BED TEMP RISE (DEG F)       341          CATALYST BED PRESS DROP (" H2O)       11.0
                     MAIN HEATER TEMPERATURE (DEG F)      750

                                                   AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                  CALCULATED    CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                           INLET CONC    ----------------------                STD.       95% C.I.
 CODE       SPECIES               (PPMV-C)        INLET      OUTLET        MEAN      DEV.     ON THE MEAN
-----------------------------------------------------------------------------------------------------------

  53      ETHANE                                   1634       170.3        89.57     0.712   ( 87.81, 91.34)
  54      ETHYLENE                                 8083        <2.0       >99.98     0.000
  55      ETHYLENE OXIDE                            206        <2.0       >99.03     0.015

  98      TOTAL VOC                                8290         4.0        99.95     0.000   ( 99.95, 99.95)

  99      TOTAL HC                                 9924       174.3        98.24     0.118   ( 97.95, 98.54)


=============================================================================================================


RUN #    F-2C        CATALYST INLET TEMP (DEG F)          609          SPACE VELOCITY                       29,335
MIXTURE  25          CATALYST OUTLET TEMP (DEG F)         942          RESIDENCE TIME (SECONDS)              0.017
                     CATALYST BED TEMP RISE (DEG F)       333          CATALYST BED PRESS DROP (" H2O)       11.0
                     MAIN HEATER TEMPERATURE (DEG F)      910

                                                   AVERAGE MEASURED             DESTRUCTION EFFICIENCY (%)
                                  CALCULATED    CONCENTRATION (PPMV-C)    -----------------------------------
SPECIES                           INLET CONC    ----------------------                STD.       95% C.I.
 CODE       SPECIES               (PPMV-C)        INLET      OUTLET        MEAN      DEV.     ON THE MEAN
-----------------------------------------------------------------------------------------------------------

  53      ETHANE                                   1691       <15.5       >99.09     0.565
  54      ETHYLENE                                 8253        <2.0       >99.98     0.000
  55      ETHYLENE OXIDE                            205        <2.0       >99.03     0.024

  98      TOTAL VOC                                8459         4.0        99.95     0.000   ( 99.95, 99.95)

  99      TOTAL HC                                10150        19.5        99.81     0.094   ( 99.66, 99.96)
```

```
RUN #    F-3      CATALYST INLET TEMP (DEG F)         598          SPACE VELOCITY                      29,286
MIXTURE  25       CATALYST OUTLET TEMP (DEG F)        893          RESIDENCE TIME (SECONDS)             0.017
                  CATALYST BED TEMP RISE (DEG F)      295          CATALYST BED PRESS DROP (" H2O)
                  MAIN HEATER TEMPERATURE (DEG F)     890

                                                   AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                   CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                            INLET CONC   ----------------------               STD.      95% C.I.
 CODE       SPECIES                 (PPMV-C)      INLET     OUTLET          MEAN     DEV.    ON THE MEAN
---------------------------------------------------------------------------------------------------------

  53      ETHANE                                  1434       <4.6         >99.68    0.135
  54      ETHYLENE                                7973       <2.0         >99.97    0.000
  55      ETHYLENE OXIDE                           104       <2.0         >98.04    0.319

  98      TOTAL VOC                               8078        4.0          99.95    0.000   ( 99.95, 99.95)

  99      TOTAL HC                                9512        8.6          99.91    0.021   ( 99.89, 99.93)


=========================================================================================================================


RUN #    F-3C     CATALYST INLET TEMP (DEG F)         598          SPACE VELOCITY                      29,286
MIXTURE  25       CATALYST OUTLET TEMP (DEG F)        893          RESIDENCE TIME (SECONDS)             0.017
                  CATALYST BED TEMP RISE (DEG F)      295          CATALYST BED PRESS DROP (" H2O)
                  MAIN HEATER TEMPERATURE (DEG F)     890

                                                   AVERAGE MEASURED           DESTRUCTION EFFICIENCY (%)
                                   CALCULATED   CONCENTRATION (PPMV-C)    ----------------------------------
SPECIES                            INLET CONC   ----------------------               STD.      95% C.I.
 CODE       SPECIES                 (PPMV-C)      INLET     OUTLET          MEAN     DEV.    ON THE MEAN
---------------------------------------------------------------------------------------------------------

  53      ETHANE                                  1387       <2.1         >99.85    0.009
  54      ETHYLENE                                7776       <2.0         >99.97    0.000
  55      ETHYLENE OXIDE                            88       <2.0         >97.55    0.740

  98      TOTAL VOC                               7864        4.0          99.95    0.001   ( 99.95, 99.95)

  99      TOTAL HC                                9251        6.1          99.93    0.002   ( 99.93, 99.94)
```

RUN # F-4
MIXTURE 25

CATALYST INLET TEMP (DEG F)	506	SPACE VELOCITY	48,647
CATALYST OUTLET TEMP (DEG F)	821	RESIDENCE TIME (SECONDS)	0.011
CATALYST BED TEMP RISE (DEG F)	315	CATALYST BED PRESS DROP (" H2O)	
MAIN HEATER TEMPERATURE (DEG F)	755		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
53	ETHANE		1541	170.1	88.96	5.361	(83.50, 94.42)
54	ETHYLENE		7918	<2.0	>99.97	0.000	
55	ETHYLENE OXIDE		56	<2.0	>96.36	0.760	
98	TOTAL VOC		7975	4.0	99.95	0.000	(99.95, 99.95)
99	TOTAL HC		9516	174.1	98.17	0.866	(97.29, 99.05)

===

RUN # G-1
MIXTURE 25

CATALYST INLET TEMP (DEG F)	602	SPACE VELOCITY	29,922
CATALYST OUTLET TEMP (DEG F)	876	RESIDENCE TIME (SECONDS)	0.017
CATALYST BED TEMP RISE (DEG F)	274	CATALYST BED PRESS DROP (" H2O)	
MAIN HEATER TEMPERATURE (DEG F)	910		

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
53	ETHANE		1906	71.1	96.28	1.800	(93.42, 99.14)
54	ETHYLENE		8706	8.9	99.90	0.002	(99.89, 99.90)
55	ETHYLENE OXIDE		199	<1.8	>99.12	0.246	
98	TOTAL VOC		8906	10.7	99.88	0.007	(99.87, 99.89)
99	TOTAL HC		10812	81.7	99.25	0.322	(98.73, 99.76)

```
RUN #    G-1C     CATALYST INLET TEMP (DEG F)          602          SPACE VELOCITY                     29,922
MIXTURE  25       CATALYST OUTLET TEMP (DEG F)         876          RESIDENCE TIME (SECONDS)            0.017
                  CATALYST BED TEMP RISE (DEG F)       274          CATALYST BED PRESS DROP (" H2O)
                  MAIN HEATER TEMPERATURE (DEG F)      910

                                                    AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                     CALCULATED   CONCENTRATION (PPMV-C)     -----------------------------------
 SPECIES                             INLET CONC   ----------------------                STD.        95% C.I.
  CODE        SPECIES                 (PPMV-C)       INLET      OUTLET          MEAN      DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

   53       ETHANE                                   1877        56.6          96.98     0.420    ( 95.94, 98.03)
   54       ETHYLENE                                 8533         8.8          99.90     0.001    ( 99.90, 99.90)
   55       ETHYLENE OXIDE                            193        <1.0         >99.48     0.008

   98       TOTAL VOC                                8726         9.8          99.89     0.001    ( 99.89, 99.89)

   99       TOTAL HC                                10603        66.4          99.37     0.075    ( 99.19, 99.56)


==============================================================================================================


RUN #    G-2C     CATALYST INLET TEMP (DEG F)          602          SPACE VELOCITY                     48,403
MIXTURE  25       CATALYST OUTLET TEMP (DEG F)         899          RESIDENCE TIME (SECONDS)            0.011
                  CATALYST BED TEMP RISE (DEG F)       297          CATALYST BED PRESS DROP (" H2O)      5.5
                  MAIN HEATER TEMPERATURE (DEG F)      886

                                                    AVERAGE MEASURED              DESTRUCTION EFFICIENCY (%)
                                     CALCULATED   CONCENTRATION (PPMV-C)     -----------------------------------
 SPECIES                             INLET CONC   ----------------------                STD.        95% C.I.
  CODE        SPECIES                 (PPMV-C)       INLET      OUTLET          MEAN      DEV.      ON THE MEAN
-------------------------------------------------------------------------------------------------------------

   53       ETHANE                                   1866       139.2          92.54     2.208    ( 89.03, 96.05)
   54       ETHYLENE                                 8499        38.6          99.55     0.021    ( 99.51, 99.58)
   55       ETHYLENE OXIDE                            207        <2.0         >99.03     0.035

   98       TOTAL VOC                                8706        40.6          99.53     0.020    ( 99.50, 99.56)

   99       TOTAL HC                                10572       179.9          98.30     0.374    ( 97.70, 98.89)
```

RUN # G-3
MIXTURE 25

CATALYST INLET TEMP (DEG F) 500
CATALYST OUTLET TEMP (DEG F) 812
CATALYST BED TEMP RISE (DEG F) 312
MAIN HEATER TEMPERATURE (DEG F) 758

SPACE VELOCITY 48,892
RESIDENCE TIME (SECONDS) 0.011
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
53	ETHANE		1836	334.0	81.65	5.349	(76.04, 87.27)
54	ETHYLENE		7988	44.7	99.44	0.054	(99.38, 99.50)
55	ETHYLENE OXIDE		187	<2.0	>98.93	0.027	
98	TOTAL VOC		8176	46.7	99.43	0.053	(99.37, 99.48)
99	TOTAL HC		10012	380.7	96.19	0.902	(95.25, 97.14)

RUN # G-4
MIXTURE 25

CATALYST INLET TEMP (DEG F) 500
CATALYST OUTLET TEMP (DEG F) 961
CATALYST BED TEMP RISE (DEG F) 461
MAIN HEATER TEMPERATURE (DEG F)

SPACE VELOCITY 46,447
RESIDENCE TIME (SECONDS) 0.011
CATALYST BED PRESS DROP (" H2O)

SPECIES CODE	SPECIES	CALCULATED INLET CONC (PPMV-C)	AVERAGE MEASURED CONCENTRATION (PPMV-C)		DESTRUCTION EFFICIENCY (%)		
			INLET	OUTLET	MEAN	STD. DEV.	95% C.I. ON THE MEAN
53	ETHANE		1735	74.4	95.71	1.002	(94.69, 96.73)
54	ETHYLENE		12594	51.1	99.59	0.038	(99.56, 99.63)
55	ETHYLENE OXIDE		187	<2.0	>98.93	0.029	
98	TOTAL VOC		12782	53.1	99.58	0.037	(99.55, 99.62)
99	TOTAL HC		14517	127.5	99.12	0.148	(98.97, 99.27)